B-777 SYSTEMS AND EXPANDED QRH

The pages following are designed to be a study guide. This information is not updated, any differences between this guide and the Company Manuals are unintentional, the Company manuals are controlling.

Personal techniques have been added in green italicized text and are additional to company SOP and are not intended to change existing SOP.

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0. Unannunciated Systems

μ ABORTED ENGINE START

See Engines

μ BOMB ON BOARD

CONDITION:

- Specific threat that a bomb is on board, or a suspected or confirmed bomb is on board.

REASON:

- Some idiot, who ought to be shot, is causing trouble
- **In The Air:** Assess the Validity of the threat. Red or Green. If in doubt assume Red Threat.
  If Red:
  Turn towards **nearest suitable airport** but **do not** begin descent. Don't rush this choice!
  Do not do anything else until completing the Checklist.

CHECKLIST:

- **Objective:** To maintain the cabin altitude, not allowing it to climb or descent but at the same time reduce the differential as much as possible.
- **PA:** **"Purser To The Flight Deck Immediately".** Brief as per the FOM and current situation.
- **LANDING ALTITUDE SELECTOR – PULL, SET MANUALLY**.
  - Set to indicated cabin altitude. (So as to keep the cabin altitude constant in case of barometric sensitive devices).
- **Plan to land at the nearest suitable airport.** (Confirm that this is the best choice)
- **DESCENT – INITIATE**
  - Descend to indicated cabin altitude, terrain permitting. Do this **promptly** at this stage of the checklist
  - (Don't descend below the indicated cabin altitude until a/c has been depressurized).
- **When cabin differential pressure is zero:**
  - OUTFLOW VALVE SWITCHES (Both) – Put to MAN and OPEN.
  - Position outflow valves fully open to depressurize airplane.
- **After landing:**
  - DISEMBARKATION / EVACUATION – INITIATE (At Captains discretion).

NOTES:

- Case where descent cannot be completed to indicated cabin alt: There will still be a cabin diff but this is acceptable as it is at least reduced. Do **NOT** depressurize, as this will cause the cabin to climb. When able descent to indicated cabin altitude and cabin diff is 0 then complete the checklist.
- **During descent get out the FOM.**
  - Refer to the FOM Chapter 14 (Safety and Security), Sabotage / Bomb Threats – In Flight.
  - PA - To Passengers as per laid down in FOM Chapter 14 (Safety and Security).
- SATCOM – Contact Duty manager.
- Make haste to diversion airfield!
- Stay at the indicated cabin altitude until destination. Do not descend from this until ready for the approach. Select Flap 5 (At least LE devices) and extend the Gear.

FCI 97/153

- Definitely know there is a bomb on board – evacuate via slides.
- Presence of a bomb not confirmed – use discretion but in most cases use the air-bridge or steps.
- Do not use exits at or near bomb, if applicable.
- Thoughts on a controlled evacuation:
  - Stop on the runway and set the park brake.
  - "**Cabin Crew At Stations. Purser To The Flight Deck**" Brief Purser to evacuate in a controlled & calm manner at the evacuation command.
  - Accomplish the standard evacuation checklist i.e**. "Passenger Evacuation Checklist"**

ON THE GROUND

- **PARKED AT THE GATE:**
  - Use the procedure laid down in the FOM Chapter 14 (Safety and Security) Red Warning Basic Procedure – **On Ground, Parked At The Gate**.
  - Drill includes:
    - PA - "***Purser To The Flight Deck Immediately***". (When Purser arrives in the Flight Deck, ask them to standby)
    - Notify ATC and Handling Agent.
    - Disconnect Bowser and remove it.
    - Maintain electrical power.
    - Shutdown engines. (Get towed in if tow truck still available)
    - Brief Purser as per FOM. Remember to disarm doors.
    - PA as per FOM.
    - Once all pax are off – Tell crew to leave the aircraft and hand the matter over to ground staff/ police
- **ON GROUND TAXING.**
  - Stop the aircraft and set park brake. "***Cabin Crew At Stations***".
  - Use the procedure laid down in the FOM Chapter 14 (Safety and Security) Red Warning Basic Procedure – **On The Ground Taxiing**.
  - Drill includes:
    - PA - "***Purser To The Flight Deck Immediately***". (When Purser arrives in the Flight Deck, ask them to standby.)
    - Proceed to the designated area as instructed by ATC.
    - If mobile steps not available, plan a controlled evacuation using the slides. *(Evacuation signal & PA).*
    - Maintain electrical power. This may require starting the APU
    - Shutdown engines.
    - Disembark Pax using mobile steps if available within a short time period. *(Seat belt signs – Off. Emergency exit lights on & PA announcement).*
    - Brief Purser.
    - If a device has been discovered carry out full emergency evacuation using slides. "***Passenger Evacuation Checklist"***.

μ DITCHING

CONDITION:

- Airplane Ditching and Evacuation are required

REASON:

CHECKLIST:

- Below 5000 ft:
- Put both PACKS OFF and close both Outflow Valves
- Ensure Gear UP and Flaps 30
- Advise Cabin of imminent touchdown.
  - Two minutes to touchdown, **"Attention Crew at Stations"**.
  - Thirty Seconds to touchdown, **"Brace, Brace"**.
- After impact:
  - Both Fuel Control Switches to Cut-off
  - Override and Pull APU Fire Switch

NOTES:

- Refer to FOM 20.4 Transmit MAYDAY and position
- Ensure Lights are all ON
- Prepare Cabin – Advise Purser – NITS
- Brief FO to make the cabin announcements
- Jettison Fuel or stay airborne as long as possible so that rescue services can get to you or you to them
- This is far better performed under power with flaps at 30
- Swells can be identified from higher – Wind can be assessed below 1500 ft. Use ND
- If wind > 35 Kts – land into wind (Foam and Spray off waves)
- If wind < 35 Kts – land parallel to swell and into wind if possible
- Do not fly into a swell!!!
- Fly on at a low Rate of Descent – Don't stall it on. Use 10° nose up attitude
- After impact announce – **"All Available Exits Evacuate, Evacuate"**. Sound the evacuation signal.

μ DUAL ENGINE FAIL/STALL

- **See Engines**

μ ENGINE IN-FLIGHT START L, R

- **See Engines**

μ GEAR LEVER LOCKED DOWN

- **See Landing Gear**

μ OVERWEIGHT LANDING

- **Condition:** A landing at greater than max landing weight is required
- **Reason:** Diversion or Return with Jettison System Inop or Quick Return

CHECKLIST:

- Refer to Landing Climb Limit Weight
  - If landing weight greater than Landing Climb Limit Weight then use flaps 20/5
  - If not use Flaps 25 or 30 depending on Vref

NOTES:

- Landing Climb Limit Weight in Performance In-flight QRH ensures:
  - ***3.2% Gross*** Climb Gradient with ***2 Eng*** and Flap 30 Gear Down
  - ***2.1% Gross*** Climb Gradient with ***1 Eng*** and Flap 20 Gear Up
- Heavy Penalties apply in icing conditions – **20 Tonnes**
- This does not necessarily ensure obstacle clearance, particularly on 1 engine
- Even if using flaps 20 there are no guarantees. Its just better than flap 30
- ***Any airport elevation above 3000 ft just use Flaps 20 – the Table only goes up to 3000 ft***

μ PASSENGER EVACUATION

CONDITION:

REASON:

CHECKLIST:

NOTES:

μ SMOKE/FUMES AIR COND

- **See Fire Protection**

μ SMOKE/FUMES/FIRE ELEC

- **See Fire Protection**

μ SMOKE/FUMES REMOVAL

- **See Fire Protection**

μ VOLCANIC ASH

- **See Engines**

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1. Airplane General

Synoptic Display

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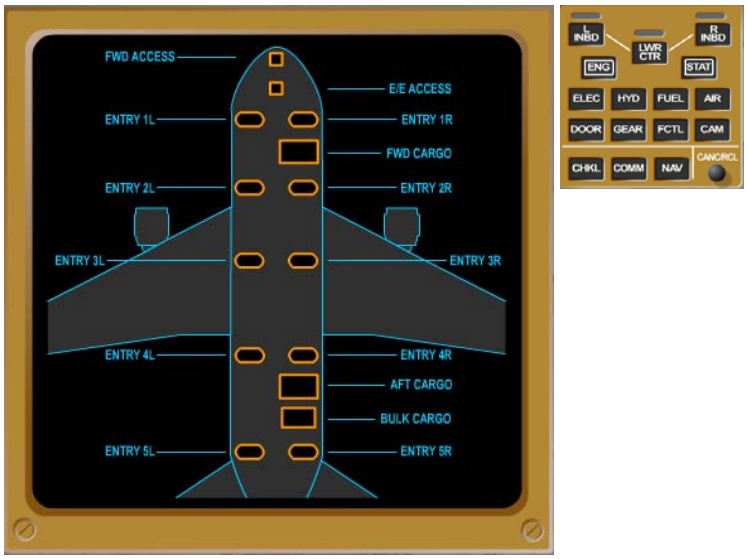

Cabin Doors

- The Entry Doors are translating, plug-type doors. During opening, the door first moves inward and upward, then translates outward and forward.
- The Door is held open by a gust lock when the door is fully open.
- Initial movement of any handle opens the vent to equalize the cabin and ambient pressure.
- The mode selector lever arms and disarms the pneumatic assist system and evacuation slide/raft of each door.
- If the Door is opened from the outside the mode select lever automatically moves to the DISARMED position.
-

Flight Deck Doors

- The Flight Deck Door is constructed out of Kevlar and consists of a deadbolt, shear pins, security grill and an emergency egress panel.
- Flight deck access system consists of Flight Deck Door Lock Panel, Flight Deck Emergency Access Panel and a Flight Deck Access System Switch
-

CREW OXYGEN LOW

CONDITION:

- Crew oxygen pressure is low

REASON:

- Oxygen leak. Pressure is below 500psi

CHECKLIST:

- NIL

NOTES:

- Check if pressure is below Performance Dispatch Figure
- Get a portable O2 cylinder for each crewmember on duty.
- Refer to FOM: Chapter 17 Use of equipment
- Negotiate a descent to FL250
- Fuel may be inadequate to reach destination so prepare for a tech stop. Contact SMNC

□ DOOR FWD CARGO (DOOR AFT CARGO ON –300) ..... Caution Message with Beeper

CONDITION:

- Forward cargo door is not closed and latched and locked.
- The forward cargo door is not a plug type door, it opens outwards, is positioned in front of the right hand engine and as cabin differential pressure increases, this pressure will attempt to push the door open.
- The primary task is to reduce the cabin differential.

PF

- Level off.
- Speed as current / required / structural damage.

PNF

- Advise ATC – problem & current altitude.

PF

- Call for the Door FWD Cargo checklist.

CHECKLIST:

- **Objective:** To reduce the Cabin Diff ASAP to prevent door from blowing
- Landing altitude selector - pull, set 8000.
- *[Reduces cabin differential pressure to decrease risk of door separation]*
- If airplane altitude at or below 8000 feet:
- Level Off - Initiate. Level off at lowest safe altitude.
- If airplane altitude above 8000 feet:
- Descent – Initiate….Descend to lowest safe altitude or 8000 feet whichever is ***higher***. *[Reduces cabin differential pressure]*
- ***May need to do a PPOS hold to accomplish checklist and determine where to go.***
- Allow sufficient time for cabin altitude to ***stabilize***. (Cabin Rate of Climb = 0).
- *[Minimizes passenger discomfort from effects of cabin depressurization].*
- Outflow valve switches (Both) - Man
- Outflow valve switches (Both) - Open.
- Position outflow valves fully open to depressurize airplane.
- Once depressurized, the crew may change altitude as necessary.

NOTES:

- If the door opened, the right engine could ingest debris from the forward cargo hold. If the door itself separated, then structural and pressurization problems may occur. Prioritize as per EICAS.
- Even if an engine failure occurs due to debris it is probably a good idea to complete the Door Fwd Cargo checklist when appropriate. (Follow the EICAS / ICON rules).
- For the case of lowest safe altitude above FL100/140 When a/c is depressurized:
  - Cabin altitude warning at FL100.
  - Pax oxygen deploys at FL140.
  - Cabin Altitude Recall / Checklist – Go through the steps carefully
  - Note: Passengers must use O2 any time the cabin alt is above 15000ft (FOM 15.4)

□ DOOR FWD OR E/E ACCESS

CONDITION:

- The E and E door is not closed and latched and locked.

NOTE:

- The door is in a safe configuration as long as cabin pressurization is normal.
- *[Positive cabin differential pressure ensures door remains in place].*

□ DOOR AFT OR DOOR BULK CARGO

CONDITION:

- The Bulk cargo door is not closed and latched and locked.

NOTE:

- The door is in a safe configuration as long as cabin pressurization is normal.
- *[Positive cabin differential pressure ensures door remains in place].*

□ DOOR 1-4 L, R DOOR 1-5 L, R

CONDITION:

- Entry door is not closed and latched and locked.

NOTE:

- The door is in a safe configuration as long as cabin pressurization is normal.
- *[Positive cabin differential pressure ensures door remains in place].*
- Advise Purser. Caution required when in the vicinity of the door after landing

PASS OXYGEN ON

CONDITION:

- Passenger Oxygen System is activated

NOTES:

- If this has happened due to system malfunction or unintentionally discuss course of action. Get to 290 - 310. Contact SMNC and ask where to take aircraft and altitude legalities.

□ WING SLIDE L, R

CONDITION:

- The door for the unpressurised wing slide compartment in not closed and locked.

NOTES:

- This door is not pressurized.

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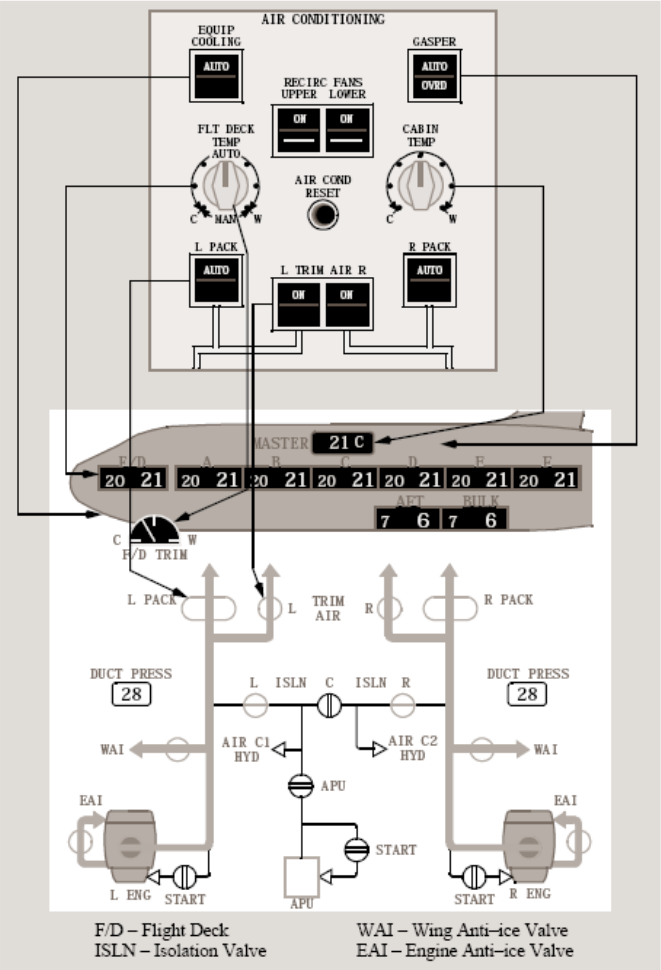
2. Air Systems

Bleed Air

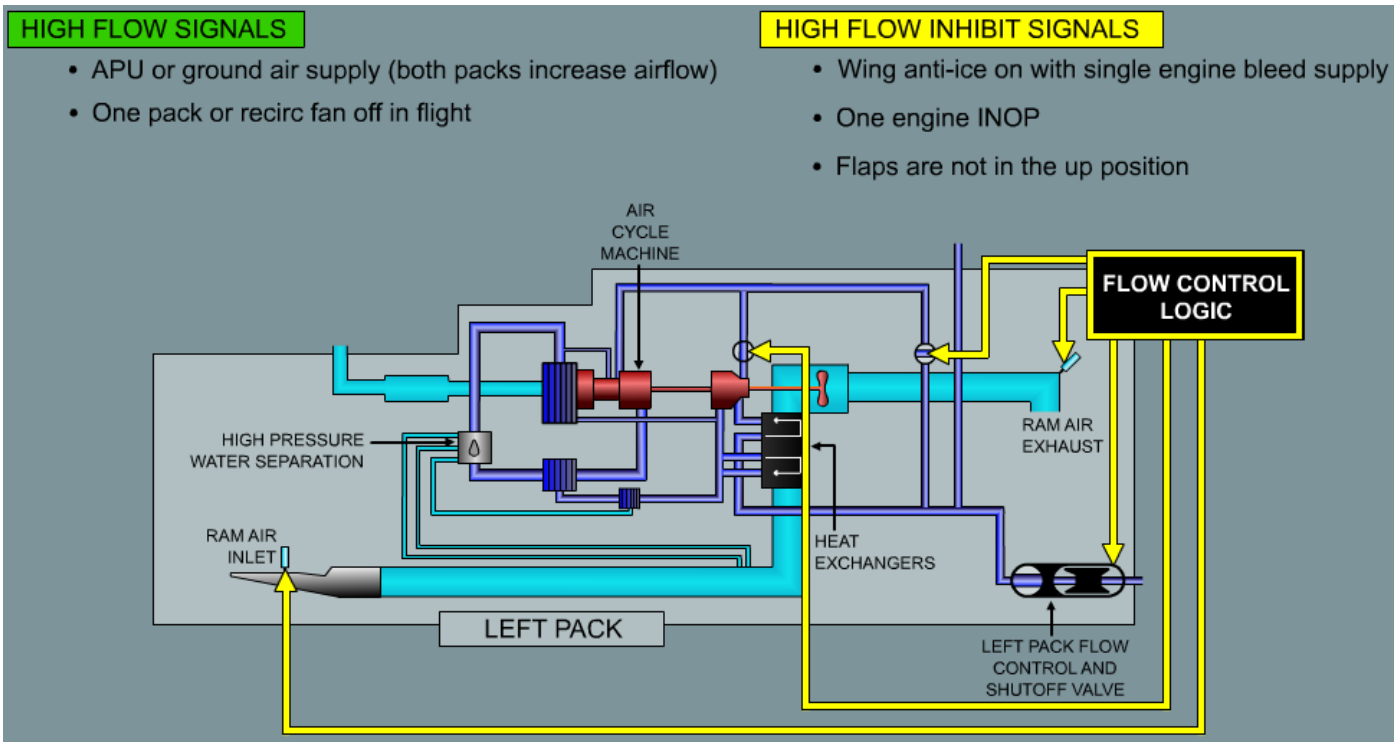
- Bleed air is used for air driven hydraulic pumps, wing anti-ice, cargo heating, engine and APU starting, air conditioning, potable water pressure, hydraulic reservoir pressure, and trim air.
- APU Bleed Air may be used in-flight to an altitude of approximately 22,000 feet.
- Engine Bleed Air comes primarily from the LP section, HP Air is available when required e.g. at low power setting during descent.
- The Air Supply Cabin Pressure Controller ASCPC regulates HP Valve and PRSOV.
- When an Engine is started it provides bleed air and the APU bleed valve is closed.
- Selecting the second engine to start closes the Engine bleed valve, the associated isolation valve, and opens the APU bleed valve.
- When both engines are running the engine bleed valves open the center isolation valve closes and the APU bleed valve closes.
- Bleed Isolation Valves are controlled automatically by the ASCPC
    - Ground Cart use, all valves open.
    - APU on all engines off, all valves open.
    - Left or right engine start, APU valve and starting engine valve open, opposite engine valve closed.
    - During cross-bleed start all valves open.
    - During engine out ops all valves open.



Bleed Air Non-Normal Operations

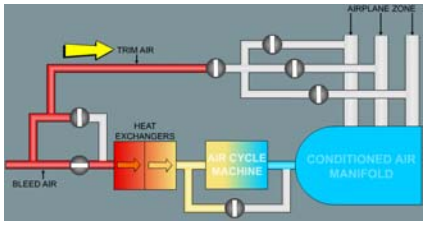
- If a leak is detected bleed valves and isolation valves are closed to isolate the duct.
- This system is automatic, crew action is not required.
- If there is a fault in the Engine or APU bleed system it will isolate and be unavailable.
- If an Isolation valve fails open there will be no loss of system functions and crew action is not required.
- If an isolation valve has failed closed, cross-bleed start will not be available.

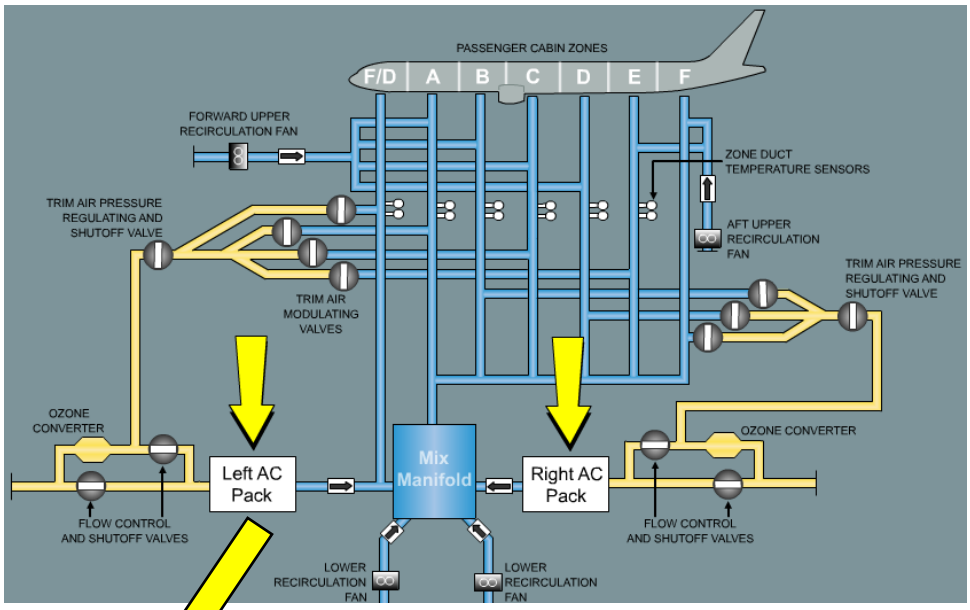
Pack Flow

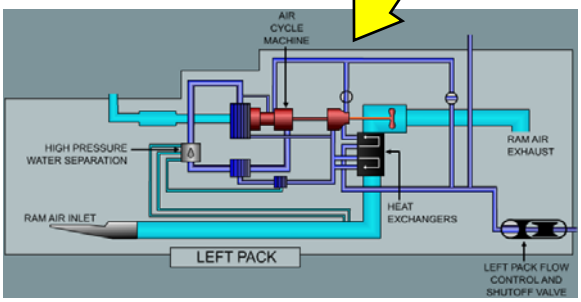


- The Packs are capable of producing higher than normal flow for air conditioning under certain operating conditions. The high flow system is automatic and is armed for operation at all times.
- During ground operation whenever the APU or ground source is supplying air for air conditioning both packs increase airflow. In flight if on pack or recirculation fan is off, or inoperative, pack airflow is increased.
- The pack high flow system is inhibited under the following situations: Wing anti-ice on and only one engine is supplying bleed air, one engine is inoperative, or flaps are not in the UP position.

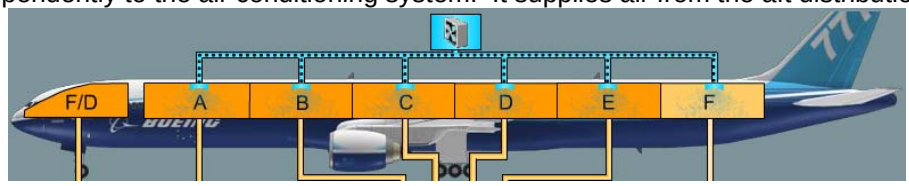
Air Conditioning



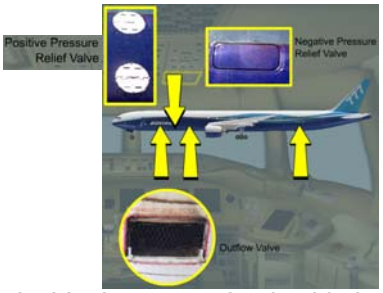




- 2 packs, a trim air system, 2 upper and 2 lower recirculation systems, and the gasper system supply the air conditioning system.
- Ram cooling air for the packs heat exchangers enters through 2 variable inlet scoops and exhausts through doors on the underside of the fuselage.
- Trim Air modifies conditioned air for all zones except the zone requiring the coolest air.
- Auto control allows temp control 18ºC-29ºC.
- Manual Selection allows positioning of the Flight Deck trim air valve.
- Cabin temp control adjusts the master temp for the cabin. Zones can be modulated by the cabin crew.
- Adjusting the master temp from 24ºC reduces the control of the Cabin Crew.
- The Gasper system operates independently to the air conditioning system. It supplies air from the aft distribution duct.



Pressurization



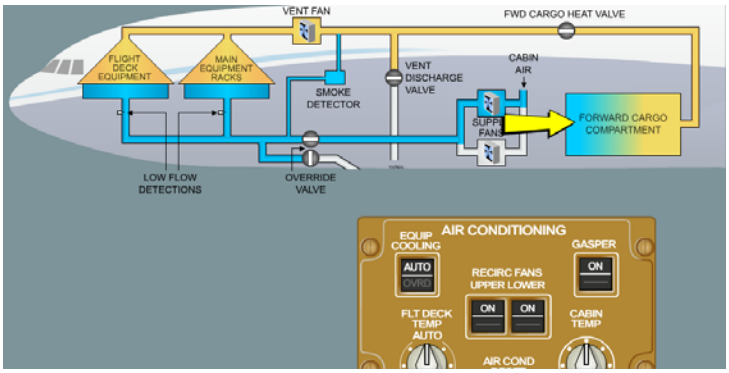
- The pressurization system controls air pressure inside the pressurized cabin by regulating the discharge of conditioned air through two outflow valves, one forward and one aft.
- Each valve is capable of maintaining full cabin altitude and ventilation. Both have an automatic and manual mode.
- Negative and positive pressure relief valves protect the fuselage from excessive pressure differentials.
- There are 4 negative pressure relief valves, 2 per side. And 2 positive pressure relief valves located on the forward left side of the fuselage.

Recirculation Fans

- Air for Upper Recirculation fans comes from above the passenger compartment.
- Air from the Lower Recirculation fans is directed into the conditioned air manifold.
- Air for the Gasper fan comes from an aft distribution duct and operates independent of the air conditioning system

Forward Equipment Cooling System

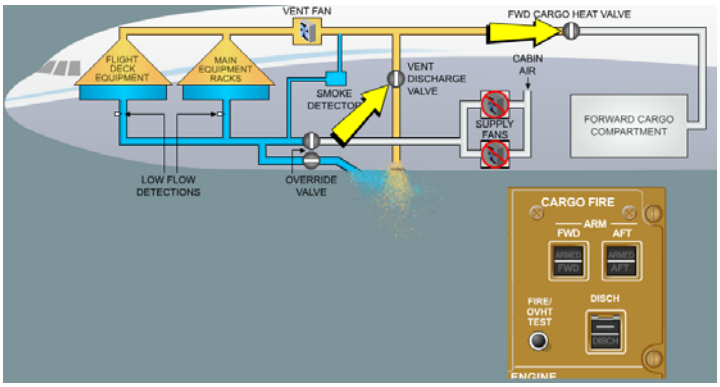
- In Auto a supply fan pulls air from the cabin, by a smoke detector and airflow sensors. The airflow sensors detect fan failures by lack of airflow.
- Cooling air enters the FD panels displays and equipment racks from below and is drawn into the exhaust vents by an exhaust fan. The exhaust fan sends air to the forward cargo compartment for heating.
- In flight exhaust air always goes through the forward cargo compartment. On the ground exhaust air will go into the forward compartment or overboard depending on TAT.



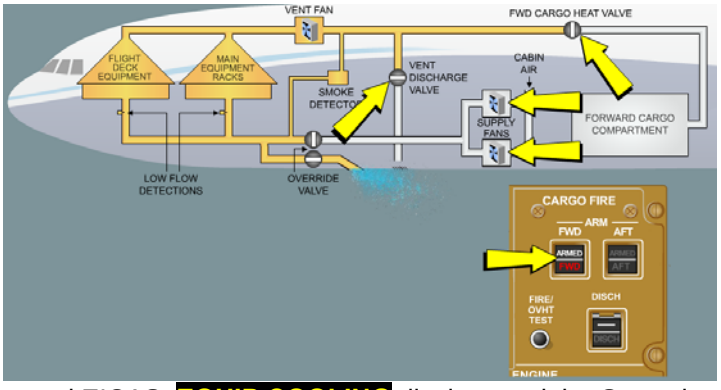
- The override valve is actually two valves mechanically linked together and is normally open to allow airflow through the ducts. Certain non-normal situations will require closure of this valve.

Forward Equipment Cooling System Non-Normal Operations

- The Forward system reconfigures override mode when:
  - The equipment cooling switch is off.
  - In-flight both supply fans fail.
  - In-flight low airflow is detected.
  - Smoke is detected in the Forward Equipment cooling or Forward Equipment Ventilation systems.
  - FWD CARGO FIRE switch is armed.
- If EICAS message **EQUIP COOLING OVRD** is displayed minimize time at low altitude to avoid equipment/display failure:
- Equipment Cooling Override mode, Forward Cargo Fire Switch not armed:
  The supply fans are inoperative, the vent valve opens, and the forward cargo heat valve closes



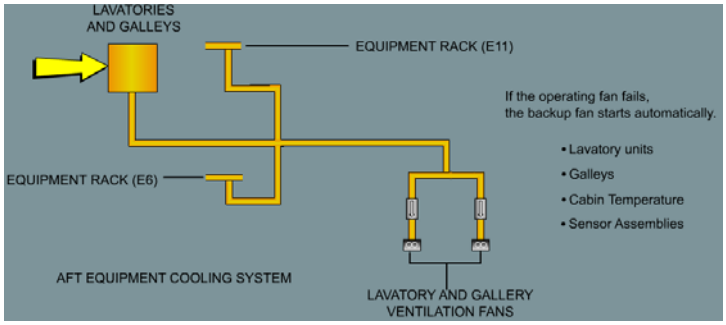
- Equipment Cooling Override mode, Forward Cargo Fire Switch armed:
  The supply fans are inoperative and the vent valve and forward cargo heat valve close, and supply fans are operative.



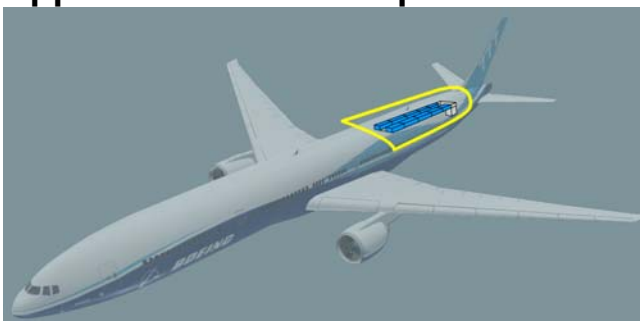
- If the FWD CARGO cooling system inoperative on the ground EICAS **EQUIP COOLING** displays and the Ground crew call in the wheel well sounds.

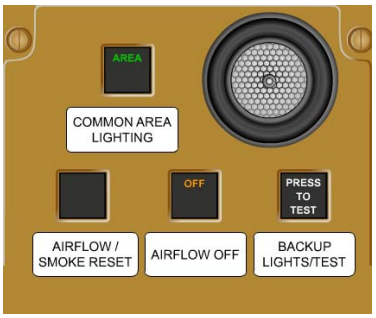
AFT Equipment Cooling System

- A Fan draws conditioned air through the equipment rack and then exhausts near the aft pressurization outflow valve. Lavatory units, galleys, and cabin temperature sensor assemblies are also ventilated by the aft equipment cooling system.
- Two fans are used, one is the operating fan the second is the backup fan that will start automatically if the operating fan fails.



Upper Crew Rest Compartment





- The AIRFLOW OFF light is illuminated whenever the Aircraft is below 25,000 feet, during smoke detection mode, when the compartment airflow exhaust valves are open or when the compartment airflow is off.
- The HI/LO chime will sound 5 times in the compartment whenever the air supply shutoff valve is commanded closed.
- Pushing the Airflow reset button for 2 seconds should reset the system if required. This switch is inoperative below 25,000 feet.

Cargo Heat for Aft and Bulk Compartments

- In Low the temperature is maintained between 4º and 10ºC.
- In High the temperature is maintained between 18º and 24ºC.
- The Bulk Cargo compartment also has a ventilation fan that operates when the Bulk temp selector is in High.

Shoulder and Foot Heaters

- Foot and Shoulder heaters work only in flight.

Non-Normals

- Pack overheat protection, fault detection and pack control are all automatic. If a significant fault or overheat is detected, the pack shuts down automatically. EICAS will display **PACK L** or **PACK R**.

- **PACK L** or **PACK R** can mean pack switch off, pack failure, Bleed Air shut off to pack, or pack Overheat.
  - The corresponding pack is automatically shut off, it can be reset after a cooling period by pressing the AIR CON RESET switch.
- **TRIM AIR L** or **TRIM AIR R** can mean Trim air switch off, Trim valve failed closed, zone duct overheat.
  - Trim Air is shut off, it can be reset after a 2 minute cooling period by pressing the AIR CON RESET switch.
- **PACK MODE L** or **PACK MODE R** can mean Air cycle machine failure, valve or temperature sensor failure that allows the system to revert to the standby cooling mode.
  - If in an area of insufficient cooling bleed air to the pack is shut off.
  - If in an area of sufficient cooling Bleed air flows by heat exchangers and added to the conditioned air manifold.
- **EQUIP COOLING** can mean low airflow, or high air supply temperature. This message will activate the ground crew call horn in the wheel well.
- **EQUIP COOLING OVRD** can mean Equipment cooling fans inop, smoke detected in ducts, low air flow, system faults, standby power operation, arming fwd cargo fire arm switch, EQUIP COOLING switch off.
  - Supply and exhaust fans are turned off, the Fwd compartment heat valve closes, the smoke override valve opens and air is vented overboard causing a reverse cooling airflow through the E/E equipment racks. Airflow varies with differential pressure.
  - Cycling the switch will reset the system.
- **CARGO HEAT AFT** can mean valves failing closed, Lav-Galley fan failure, or Temp probe failure.
  - Cargo heat for the affected compartment is inop, crew action not required.

GENERAL

- Study Air Synoptic after initial problem / action checklist to determine what further problems may exist.
- An engine failure or further bleed air loss may well result in depressurization and/or loss of ADP's giving further performance problems.
- An EICAS **BLEED BODY LOSS** will result in a severe go around performance penalty as the ADP's will not be powered and gear retraction will take 3 minutes. If an engine is inoperative, ***avoid high terrain airports / high-density altitude airports***. Try to opt for an ILS, good weather etc and get an early landing clearance.
- EICAS messages **HYD PRESS DEM C1** & **HYD PRESS DEM C2** indicates that the ADP's are not powered. Flaps and Slats may go to secondary mode and the **FLAPS PRIMARY FAIL**, **SLATS PRIMARY FAIL** messages will be displayed due to high hydraulic demand. Gear retraction will take 3 minutes. If an engine is inoperative, ***avoid high terrain airports / high-density altitude airports***. Try to opt for an ILS, good weather etc and get an early landing clearance.
- To recover pressurization by use of APU below FL220, both bleed air ***switches*** must be ***off.***
- Brief what may happen with a further loss of engine or bleed air and make a plan of action should this occur. E.g. descent.
- Beware of Air System MEL. If dispatching with bleeds or packs compromised, consider implications over high terrain, or in icing conditions of an additional bleed loss due to leak in the bleed or anti-ice systems
- If an engine bleed valve is closed, the opposite engine goes to Approach Idle to cater for the increased air demand. This may result in an **ENG IDLE DISAGREE** message

□ BLEED ISLN CLOSED C, L, R,

CONDITION:

- Isolation Valve remains closed when commanded open or Bleed Isolation Switch is OFF

REASON:

CHECKLIST:

- No Actions required or Notes

NOTES:

- Normal configuration in flight is:
  - Center Isolation Valve – closed.
  - L an R Isolation Valves – Open
- This as a single failure should not provide much of a problem, as the other valves will reconfigure to ensure all components in the center duct are supplied with air
- If and engine fails however there may be problems as essentially you may have a **BLEED LOSS BODY**
  - In the worst case Center Duct may not be pressurised leading to loss of ADP's, which will affect G/A performance, as gear will take time to retract. Approx 3 min. You will be warned by the **HYD PRESS DEM C1, C2** during the approach when putting out flaps. The **HYD PRESS SYS C** and **GEAR DISAGREE** will be displayed during retraction.
  - Flaps and Slats may go to secondary mode **FLAPS PRIMARY FAIL**, **SLATS PRIMARY FAIL** due to high hydraulic demand
  - Flaps will take time to extend
  - Wing TAI will not be available on one side. Expect **ANTI ICE WING**

□ BLEED ISLN OPEN C, L, R,

CONDITION:

- Isolation Valve remains open when commanded closed

REASON:

- Valve has failed

CHECKLIST:

- No Actions required or Notes

NOTES:

- Normal configuration in flight is:
  - Center Isolation Valve – Closed.
  - L an R Isolation Valves – Open
- This as a single failure should not provide much of a problem, as the other valves will reconfigure to ensure all components in the center duct are supplied with air
- In the event of a **BLEED LEAK**, the system would normally close bleed and isolation valves. If an Isolation Valve remains open when commanded closed, the system would close valves further upstream to isolate the leak. This will result in a variety of **BLEED LOSS** messages. Accomplish as ICONed.

□ BLEED LEAK BODY ..... Caution Message with Beeper

CONDITION:

- High Temperature bleed leak is detected in the ***body area***

REASON:

CHECKLIST:

- The ASPC automatically isolates heat source within approximately **3 min** by closing bleed and isolation valves
  - Pilot action will be required when a **BLEED LOSS** message is displayed
  - Do not accomplish the following checklists:
  - **HYD PRESS DEM C1**
  - **HYD PRESS DEM C2**

NOTES

- This will result in a **BLEED LOSS BODY** or a **BLEED LOSS BODY L / R**
- Give time for the **BLEED LOSS** message to display
- If the **BLEED LOSS** message does not appear, then the isolation has been unsuccessful. It may be prudent to land as there is a leak in the body

□ BLEED LEAK L, R ..... Caution Message with Beeper

CONDITION:

- High Temperature bleed leak is detected in the ***wing*** or ***pack bay area***

REASON:

CHECKLIST:

- The ASPC automatically isolates heat source within approximately **5 min** by closing bleed and isolation valves
- Pilot action will be required when a **BLEED LOSS** message is displayed
- Do not accomplish the following checklists:
  - **HYD PRESS DEM** ?
  - **PACK**

NOTES:

- This will lead to a **BLEED LOSS WING L, R** as the Isolation Valve and Bleed Valve will isolate that wing
- Give time for the **BLEED LOSS** message to display
- If the **BLEED LOSS** message does not appear, then the isolation has been unsuccessful. It may be prudent to land as there is a leak in the wing. Reducing thrust on that engine may cure or reduce the problems.

□ BLEED LEAK STRUT L, R ..... Caution Message with Beeper

CONDITION:

- A high temperature bleed air leak is detected in the ***strut area***.
- The air supply controller automatically isolates the heat source by automatically closing bleed and isolation valves.

REASON:

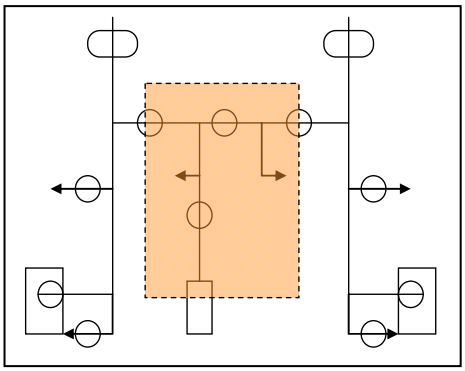
CHECKLIST:

- Wing Anti-Ice selector - Off.
- **If isolation was successful**:
  - The bleed ***leak*** message is removed when the temperature in the affected area cools.
  - The icon for the leak message may disappear shortly before the message disappears.
  - The valves isolating the leak remain closed and the appropriate bleed ***loss*** message is displayed **BLEED LOSS WING** as well as a resulting system loss checklist **PACK**.
  - These messages appear without icons and are therefore not in the non-normal checklist queue.
  - The leak checklist is in the checklist queue and has a step that needs to be accomplished which is wing anti-ice selector - off.
- **If the isolation was <u>not</u> successful**:
  - The message remains displayed i.e. the area has not cooled, operate the engine at idle or a thrust level whereby the EICAS message **BLEED LEAK STRUT** is extinguished.
  - There will still be a **BLEED LOSS WING** and a **PACK** message on EICAS
  - A flap 20 or 30 landing will have to be chosen

NOTES:

- Give the system time to isolate and cool before launching into checklists.
- If a variety of EICAS messages with icons are displayed choose one that is the causal condition, whilst also ensuring that cautions are dealt with before advisories.
- For example, if after giving the system time to isolate, the leak message is still displayed then do the leak checklist. If the leak message has disappeared and a loss plus a resultant system loss checklist is displayed, do the loss checklist, which will ask for the system loss checklist to be overridden.

□ BLEED LOSS BODY



CONDITION:

- Bleed Air from the left and right body ducts is no longer available

REASON:

CHECKLIST:

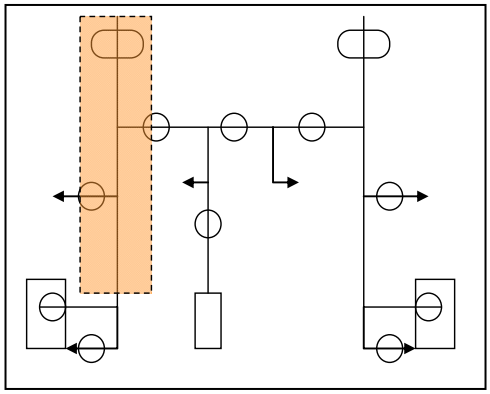
- Turn off C1 and C2 Demand pumps to prevent their messages when extending flaps
- Gear Retraction time increases to approx 3 min due to reduced C hyd system capacity. The **HYD PRESS SYS C** and **GEAR DISAGREE** will be displayed during retraction

NOTES:

- Center Duct is not pressurized leading to loss of ADP's, which will affect G/A performance, as gear will take time to retract. Approx 3 min.
- Performance is covered in the 2-engine case. In the single engine case not at all.
- Choose an airport with good Go-Around performance capability
- An EICAS BLEED BODY LOSS will result in a severe go around performance penalty as the ADP's will not be powered and gear retraction will take 3 minutes. If an <u>engine is inoperative</u>, ***avoid high terrain airports / high-density altitude airports***. Try to opt for an ILS, good weather etc and get an early landing clearance.
- Perhaps choose flap 20 landing from overweight landing performance??
- Flaps and Slats may go to secondary mode **FLAPS PRIMARY FAIL**, **SLATS PRIMARY FAIL** due to high hydraulic demand during extension. Flaps will take time to extend
- The **HYD PRESS SYS C** and **GEAR DISAGREE** will be displayed during retraction.

-

□ BLEED LOSS BODY L



CONDITION:

- Bleed air from the left body duct is no longer available

REASON:

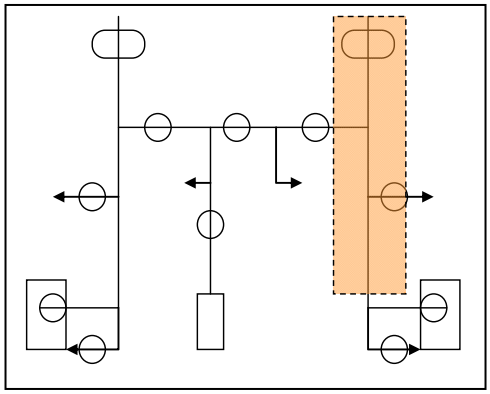
CHECKLIST:

- C1 demand pump is turned off to prevent the **HYD PRESS DEM C1** while extending flaps

NOTES:

- The gear and flaps will operate normally as long as the C2 Demand Pump is operating.
- If there is any problem that prevents the C2 pump from working, like other bleed problems or MEL items, then the Gear and Flaps will take longer to operate

□ BLEED LOSS BODY R



CONDITION:

- Bleed air from the right body duct is no longer available

REASON:

CHECKLIST:

- C2 demand pump is turned off to prevent the **HYD PRESS DEM C2** while extending flaps

NOTES:

- The gear and flaps will operate normally as long as the C2 Demand Pump is operating.
- If there is any problem that prevents the C2 pump from working, like other bleed problems or MEL items, then the Gear and Flaps will take longer to operate

□ BLEED LOSS WING L, R

CONDITION:

- Bleed air from the wing duct is no longer available

REASON:

CHECKLIST:

- The Wing Anti Ice selector is put off to prevent asymmetrical ice build-up

NOTES:

- This occurs after the wing has been isolated
- A loss of the pack or the bleed on the other side will cause a loss of pressurization as well as a bleed loss in the Body resulting in a loss of ADP's. This will result in extended gear and flap operation times.

BLEED OFF APU

CONDITION:

- APU bleed valve is closed for a system fault or APU bleed switch is off

REASON:

CHECKLIST:

NOTES:

BLEED OFF ENG L, R

CONDITION:

- Engine Bleed Valve is closed for a system fault or engine bleed switch is off

REASON:

CHECKLIST:

NOTES:

- If an engine bleed valve is closed, the opposite engine goes to Approach Idle to cater for the increased air demand. This may result in an ENG IDLE DISAGREE message

-

□ CABIN ALTITUDE ..... Warning Message with Siren

CONDITION:

- Cabin Altitude is excessive

REASON:

- Cabin Altitude is above 10000 ft due to:
- Lack of air through the packs
- Loss of pressurization control
- Explosive Decompression

NOTES:

- **Ref: FCTM 3:12. QRH – Cabin Altitude**
- If a cabin altitude warning is the first alert, the chances are that it is an explosive decompression e.g. door, window, bomb.
- The pressurization system is operating but cannot control the cabin altitude.
- A cabin altitude warning is likely to be preceded by alerts such as Bleed, Pack, Cabin Altitude Auto caution message, outflow valve aft or fwd advisory message or an amber cabin altitude indication on the AIR synoptic at **8500ft**-cabin altitude.
- In this case an attempt to regain control of the pressurization manually may be required.
- Cabin Altitude warning occurs at 10 000ft-cabin altitude.
- Passenger oxygen masks deploy automatically at 14 000FT.
- Passenger oxygen flows for approximately 20 minutes. *SEP Manual*
- If a loss of pressurization occurs, decide on the best course of action based on the current situation. Use the EICAS and the air synoptic (cabin altitude and rate - check) to determine the pressurization status.
- If the Cabin Altitude Warning occurs then accomplish the Cabin Altitude Recall.
- **Cabin Altitude Recall (QRH & FCTM)**
- ***Oxygen masks - ON. 100%.***
- ***Crew Communications establish.***
  - **"CAPTAIN ON OXYGEN". "FIRST OFFICER ON OXYGEN"**.
- *Select speaker - on. Use the INT to communicate with each other and MIC for ATC communications.*
- ***Cabin Altitude and Rate - Check.***
- This check is a quick scan to determine the pressurization status and whether the system is controllable or not.
- If the outflow valves are closed and the cabin altitude is still climbing then the system is not controllable.
- In the event of an explosive decompression then a rapid descent should be carried out immediately.
- PF call for the "**CABIN ALTITUDE RECALL**" or announce "**RAPID DESCENT - CABIN ALTITUDE RECALL**"
- PNF: If the outflow valves are open then try to close them manually.
- Once it is established that the Cabin Altitude is Uncontrollable then do not bother with the Outflow Valves any further. In the Descent the ASCPC's will probably open then in the Descent to avoid Negative Differentials. Do NOT close them at this stage as the decision has been made and this may result in a Negative Differential.
- ***If cabin altitude uncontrollable:***
  - ***Passenger oxygen switch - push and hold for 1 second. (PNF)***
  - ***Descent - Accomplish. (PF)***
- **PF**
  - Announce "**RAPID DESCENT -CABIN ALTITUDE RECALL**".
  - Accomplish the applicable drill:
  - Reset MCP altitude. HDG SEL L/R off airway. FLCH – speed window opens to current IAS. Thrust Levers to idle. Extend the speedbrakes. MCP speed as required (MMO/VMO or if structural integrity is in doubt then maintain present speed).
  - Heading or Track so as to parallel the airway.
  - MCP altitude to MEA/MORA/10 000ft.
  - R/T as required.
  - Fly IAS not MACH. Approaching the level off altitude, as the nose pitches up and the aircraft decelerates, stow the speedbrake and transition to the required cruise speed.
  - Call for other non-normal checklists using EICAS if applicable. Other pressurization checklists may restore the pressurization.

- **PNF**
  - Verify that the cabin altitude recall items have been accomplished.
  - R/T – give a Mayday call if the PF hasn't.
  - Check MEA.
  - Accomplish the Cabin Altitude checklist and other applicable checklists as per the EICAS.
  - Call FL 200, 2000 and 1000 feet to go to level off.

NOTES:

- **Carry out the drill slowly and deliberately. Don't rush.**
- The **Rapid Descent drill** is a drill that may be accomplished as part of the Cabin Altitude Recall or as a separate drill depending on the circumstance. E.g. For a dual pack failure at altitude the PF may announce ***"Rapid Descent"*** and then ask the PNF to accomplish the Pack left and Pack right checklists. If a cabin altitude warning alert is then received, accomplish the Cabin Altitude Recall.
- In practice, the first pilot on oxygen with his act together should be the PF.
- In the case of a Rapid Descent without a Cabin Altitude Warning, transmit a ***"Cabin Crew take your seats"*** PA call.
- When ready; go off oxygen one at a time. Remove the oxygen mask, close the left mask door (Mic is changed from the mask setting to boom) and press Reset (Stops the oxygen flow).
- If oxygen is subsequently needed: open the left mask door and don the oxygen mask.
- CRM – Weather and where to go. Brief the cabin crew. P.A.
- Note **PA must state**: Aircraft is Level, Altitude maintaining, Reason, Time (NITS)
- Vol 2A Chapter 1. Further notes on the cabin signs, emergency lighting, Pax oxygen system and oxygen mask panel.
- After Level a PA must be made at some time. This must announce the altitude that the aircraft is at and the intensions. Also state whether or not oxygen is still required

□ CABIN ALTITUDE AUTO ..... Caution Message with Beeper

CONDITION:

- Automatic pressurization control has failed or both outflow valve switches are in manual

REASON:

CHECKLIST:

- Both Outflow Valves are put to Manual and the pressurisation is controlled using the outflow valves.
  - Note: The valves may take up to 6 seconds to begin to move
  - Note: Recommended cabin rate is approx 500fpm for climbs and descents
  - Note: A table of FL vs. cabin altitude is given to assist in setting the outflow valves
- At pattern altitude the Outflow valves are fully opened

NOTES

- The cabin altitude will have to be carefully monitored during climbs and descents.
- This may not be really practical for a long flight.
- Consider limiting altitude for cruise in case of finger trouble
- Consider the commercial implications of a diversion

□ CARGO HEAT AFT, BULK

CONDITION:

- Cargo Heat is inoperative or cargo temperature selector is off

REASON:

- Both Vent Fans have failed
- An automatic overheat shutdown has occurred

CHECKLIST:

- No actions are necessary

NOTES:

- Check the temperature on the Air Synoptic
- If animals are carried the temperature is unlikely to get too low as the compartment is heated by air flowing down from the cabin
- Consider that the animal may be valuable so a tech stop in this case may be warranted. Contact SMNC

□ EQUIP COOLING

CONDITION:

- Forward equipment cooling system is inoperative

REASON:

- Both supply fans have failed or there are other system faults

CHECKLIST:

- No actions are required

NOTES:

- This message can only display on the ground. In the air the EQUIP COOLING OVERRIDE message will display as the equipment is now cooled by air drawn through Diff Pressure
- The ground crew call horn in the wheel well is activated. This needs fairly prompt attention as the Electronic Equipment may begin to overheat and be damaged
- Consult MEL
- Consider Load shedding avionic equipment or powering down aircraft

□ EQUIP COOLING OVRD

CONDITION:

- Equipment Cooling System is in Override Mode

REASON:

- Smoke is detected in the Forward E/E compartment
- Forward Cargo Fire extinguishing system is armed
- Both E/E supply fans fail
- Low Flow is detected in Flight
- Override Mode has been manually selected

CHECKLIST:

- Wait 2 mins to allow smoke in system to clear
- Equipment Cooling Switch goes Off then Auto in an attempt to reset the equipment cooling
- If the Equipment Cooling Override message remains
- After 30 mins at low altitude and cabin diff, electronic equipment and displays may fail

NOTES:

- Do all preparation at higher altitudes if possible and avoid extended holding and delays at low altitude. If holding becomes a factor consider climbing
- Monitor the Cabin Diff
- Turn down cabin temperatures
- If equipment fails, consider climbing not rushing the approach.
- As a scenario, how realistic is this because who is to say which equipment fails first?

□ LANDING ALTITUDE

CONDITION:

- FMC has failed to provide a landing altitude or land altitude selector is pulled

REASON:

CHECKLIST:

- Pull the Landing Altitude Selector and set the landing altitude manually

NOTES:

- This will be one of the consequences of a Dual FMC failure with FMC message.

□ OUTFLOW VALVE AFT, FWD

CONDITION:

- Automatic control has failed or outflow valve switch is in MAN

REASON:

CHECKLIST:

- Outflow Valve Switch to MAN.
- Close Outflow Valve
- Hold for 30 secs or until valve is fully closed. Valve may take up to 6 secs to begin moving

NOTES:

- This allows the other outflow valve to control the pressurisation. It is fully capable of providing cabin pressurisation
- If the other outflow valve fails the **CABIN ALTITUDE AUTO** caution will be given and the ***Cabin Altitude*** will have to be controlled manually.

□ PACK L, R ..... Caution Message with Beeper

CONDITION:

- Pack is shut down

REASON:

- A significant pack fault is detected. 1) Pack High Outlet Temperature
- 2) Compressor High Outlet Temp
- Flow Control Valves Failed Closed
- No Pneumatic Air
- Off is selected

CHECKLIST:

- Wait 5 min to allow pack to cool
  - Press reset switch
- Cycle Pack Off then Auto to reset
- Wait 2 min and if problem reoccurs put pack to Off (reset failed)

NOTES:

- No altitude restriction
- Other pack will go to higher flow to increase output
- Dispatch with single pack operation over Iran is prohibited
- If the other pack fails the cabin will depressurise but not explosively. Get down as soon as possible. Announce ***"Rapid Descent"***
- If CABIN ALTITUDE comes on – complete recall

□ PACK MODE L, R

CONDITION:

- Pack is operating in Standby Mode

REASON:

- The Air Cycle Machine has failed and cannot cool the air. The air is cooled purely by the Heat Exchangers. If they cannot adequately exchange the heat, the pack will shut down

CHECKLIST:

- Note: At lower altitudes and/or higher outside air temperatures, the pack may shut down

NOTES:

- If other pack is failed or in Stby Cooling, the pack will not shut down as it has to maintain cabin pressurization. This may result in higher Cabin Temps at lower altitudes and/or higher outside air temperatures
- This in itself does not threaten pressurisation as the Pack is providing air but not cooling it
- Dispatch: ??

□ TRIM AIR L, R

CONDITION:

- Trim air is shut off

REASON:

Valve is failed closed

- Zone supply duct overheat
- Trim air switch is off

CHECKLIST:

- Wait 5 mins
- Push the Reset Switch
- Wait 2 mins and if problem reoccurs put trim air switch off

NOTES:

- The Cabin Temperature Controllers CTC will attempt to maintain all zones at the average Target Temperature as set by the Master Controller.

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3. Anti-Ice & Rain Systems

Expanded Checklists

GENERAL:

- Beware of Air System MEL. If dispatching with bleeds or packs compromised, consider implications over ***high terrain, or in icing conditions*** of an additional bleed loss due to leak in the bleed or anti-ice systems.
- **Avoiding icing conditions:** Maybe divert if in clear weather to really good weather. Return to base. Ask about tops or layers. Avoid the levels where the SAT is 0 or just below. If the surface temperature is around freezing then keep above 5000ft (ELR 2º / 1000ft.). Keep high speed - 230 / 250 - 300kts to reduce airframe icing. The airplane is capable of continued safe flight and landing in icing conditions in the event of in-flight failure of the wing anti-ice system SP.3.2. Obtain Icing Pireps. If fan icing is suspected due to sustained engine vibration, accomplish the Engine Ice shedding procedure at intervals.

□ ANTI-ICE ENG L, R,

CONDITION:

- Engine Anti Ice Valve remains closed when commanded open

REASON:

- Valve has failed.

CHECKLIST:

- Attempts to reset the Engine Anti Ice by recycling the switch OFF then ON
- If this is successful the Eng TAI ***switching*** must be operated manually – Put on when **ICING ENG** displays or if in icing conditions. If it is left on and the **ANTI ICE ON** message is displayed, this will remind the crew to turn it off. This will not occur if the TAT remains below 10 and the fuel burn will increase due to the TAI left on
- If this is unsuccessful and the message remains, put the Eng TAI to OFF to allow the **ICING ENG** to come on and alert the crew that they are in icing conditions
- Note: ***Avoid icing conditions***

NOTES:

- Avoiding icing conditions. Maybe divert if in clear weather to really good weather. Return to base. Ask about tops or layers. Avoid the levels where the SAT is 0 or just below. PIREPS of icing. Engine Ice shedding procedure

□ ANTI-ICE LEAK ENG L, R ..... Caution Message with Beeper

CONDITION:

- High temperature anti ice or starter duct bleed air leak is detected in the affected engine

REASON:

CHECKLIST:

- The Eng TAI system automatically isolates the source within approx 1 min if leak is in the engine anti ice duct by closing the engine anti ice valve. This will result in the **ANTI-ICE LOSS** message
- ***Avoid icing conditions***
- If the message remains after 1 min then the Engine Bleed Switch and the Bleed Isolation Switch are put off to isolate the leak. (Isolates heat source if bleed air leak is in the starter duct) There will be a **BLEED LOSS WING** and **PACK** message. The Wing TAI selector must be put off to prevent asymmetrical ice build-up.
- If the message remains, ***reduce the thrust on the engine to idle*** (leak cannot be isolated)

NOTES:

- Give the system time to isolate the leak
- If shutting off the bleed to the wing, because the automatic isolation fails, consider the other sources of bleed air first.
- Additional problems on the other side may cause loss of bleed air altogether.
- **Avoiding icing conditions:** Maybe divert if in clear weather to really good weather. Return to base. Ask about tops or layers. Avoid the levels where the SAT is 0 or just below. If the surface temperature is around freezing then keep above 5000ft (ELR 2º / 1000ft.). Keep high speed - 230 / 250 - 300kts to reduce airframe icing. The airplane is capable of continued safe flight and landing in icing conditions in the event of in-flight failure of the wing anti-ice system SP.3.2. Obtain Icing Pireps. If fan icing is suspected due to sustained engine vibration, accomplish the Engine Ice shedding procedure at intervals.
- For the case whereby you turn the Engine Bleed Switch and the Bleed Isolation Switch are put off to isolate the leak, brief that in the event of an engine loss or bleed / pack loss on the 'good' side, the aircraft will depressurise.
- If the message remains, you have a hot air leak, probably good idea to land as soon as possible

ANTI-ICE LOSS L, R,

CONDITION:

- Anti-Ice bleed air for the affected engine is no longer available
- **REASON:**
- The anti-ice system has been isolated because of a leak

CHECKLIST:

NOTES:

- Generally, this is the result of an **ANTI-ICE LEAK ENG L, R**
- This will result in the **ANTI-ICE LOSS** message
- ***Avoid icing conditions***
- Avoiding icing conditions. Maybe divert if in clear weather to really good weather. Return to base. Ask about tops or layers. Avoid the levels where the SAT is 0 or just below. Pireps of icing. Engine Ice shedding procedure

□ ANTI-ICE ON

CONDITION:

- Any anti ice selector is ON, air temperature is above 10 C and ice is not detected

REASON:

CHECKLIST:

- Engine and Wing TAI must be put to AUTO or OFF

NOTES:

□ ANTI-ICE WING

CONDITION:

- One or both wing anti ice valves remain closed when commanded open

REASON:

CHECKLIST:

- Wing TAI OFF then ON in an attempt to reset the controller and open the valve. If the valve opens then operate manually.
- If the message remains displayed then put the Wing TAI OFF to enable the **ICING WING** message to appear if icing conditions are encountered

NOTES:

- The checklist does not say Avoid Icing Conditions. The airplane is capable of continued safe flight and landing in icing conditions in the event of in-flight failure of the wing anti-ice system SP.3.2

□ HEAT PITOT C

CONDITION:

- Center Pitot Probe Heat is inoperative

REASON:

CHECKLIST:

- Note: Standby Air Data is unreliable in icing conditions

NOTES:

□ HEAT PITOT L

CONDITION:

- Left Pitot Probe Heat is inoperative

REASON:

CHECKLIST:

- Note: ADIRU and SAARU air data is not affected for a single pitot heat failure. Ensure that the right air data/attitude source switch remains off. (This is to avoid bad data being borrowed)

NOTES:

□ HEAT PITOT L+C+R

CONDITION:

- All Pitot Probe Heats are inoperative

REASON:

CHECKLIST:

- Note: ***Air data is unreliable***

NOTES:

- This may well result in the flight controls system going into secondary mode. If this occurs then the PFC's will have to be reset when the pitot heat is restored
- This will necessitate ***Flight with Unreliable Airspeed***. See Perf In-flight

□ HEAT PITOT R

CONDITION:

Right Pitot Probe Heat is inoperative

REASON:

CHECKLIST:

- Note: ADIRU and SAARU air data is not affected for a single pitot heat failure. Ensure that the left air data/attitude source switch remains off. (This is to avoid bad data being borrowed)

NOTES:

□ ICE DETECTORS

CONDITION:

- Ice detection has failed.

REASON:

- The ice detection system has failed so no TAI automatic systems are functional

CHECKLIST:

- Note: Operate engine and wing anti ice systems manually

NOTES:

- Put the anti ice selectors to OFF (or On as required)
- Here is a good opportunity to use the Rubber Duck method for a reminder. If the temp remains below 10 this can be forgotten and left on, with large fuel penalties.

ICING ENG ..... Caution Message with Beeper

CONDITION:

- Ice is detected and one or both engine anti ice selectors are off

REASON:

CHECKLIST:

NOTES:

ICING WING

CONDITION:

- Ice is detected and wing anti ice selector is off, or ice is detected and wing anti ice takeoff inhibit is active

REASON:

CHECKLIST:

NOTES:

- This proves that despite the takeoff inhibits being in place; there is no need to put the wing anti ice selector to on prior to takeoff. The system will tell you. Of course whether or not you will do anything about it during the takeoff until climb thrust is set and the inhibit is removed is optional

WINDOW HEAT

CONDITION:

- Two or more window heats are off

REASON:

CHECKLIST:

NOTES:

□ WINDOW HEAT L, R FWD

CONDITION:

- Primary window heat for the affected forward window is off

REASON:

- There is a Fault, Overheat or the switch is Off

CHECKLIST:

- The switch is cycled to reset the controller. If the message remains the switch is put off to prevent electrical arcing. The window is defogged by the backup system

NOTES:

□ WINDOW HEAT L, R SIDE

CONDITION:

- Window heat for the affected side window is off

REASON:

- There is a Fault, Overheat or the switch is Off

CHECKLIST:

- The switch is cycled to reset the controller. If the message remains the switch is put off to prevent electrical arcing.

NOTES:

- The side windows do not have a backup system

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4. Automatic Flight Systems

- The Autoflight system consists of the Flight Director, Autothrottle, and 3 Autopilots.
- Two Autothrottle systems operate independently of each other.
- Auto selection of bank limits the bank depending on speed.
- The bank limit selector only works in the **HEADING** or **TRACK** select modes. It has ho effect on LNAV.
- The Altitude selector is rate sensitive in the **AUTO** selection only.
- At 80 knots on the Takeoff roll the Autothrottles change from **THR REF** to **HOLD.**

AUTOFLIGHT DURING TAKE-OFF

- F/D command TO/GA, TO/GA for Take-off
    - TO/GA Roll command maintains runway track.
    - TO/GA Pitch Command Starts at a parked position of 8° and as the aircraft accelerates it commands **V_2+15** (If the target speed is exceeded for more than 5 seconds it will adjust to the new speed, not to exceed **V_2+25**)
- If Flight Directors were not on and the airplane speed is greater than **80 knots**, pushing a TO/GA switch with pop up the Flight Directors.
- If the Flight Directors are on and the airplane speed is greater than **80 knots** pushing a TO/GA switch will disarm **LNAV** and **VNAV**.
- At **50 feet** AGL **LNAV** engages.
- At **400 feet** AGL **VNAV** engages. The speed window closes and the speed bug moves the VNAV commanded speed.
- Once Airborne a push of the TO/GA switch cancels the derate power selection and sets full rated Take-off thrust, it also cancels the current lateral tracking mode and tracks on the current Track.
- Selecting an Autopilot to on engages the AUTOPILOT System (3 autopilots).

AUTOFLIGHT DURING CLIMB

- At Acceleration Height the FMC commands acceleration to 5 knots below Flap placard speed.
- As flaps are retracted the FMC sets the next target airspeed.
- When reaching Thrust Reduction Altitude or flap settings set in the FMC the Autothrottle sets Climb Limit. If VNAV is not engaged Climb thrust can be engaged by Selecting **FLCH** or **CLB/CON** thrust switch.
- Speed Intervene can be used to adjust the climb speed schedule.
- Altitude Alert occurs when within **900 feet** of the MCP altitude.
- After level off an Altitude Deviation Alert occurs if the aircraft deviates **200 feet** from the MCP altitude.
- Climb in FLCH will adjust the Vertical speed dependant on the required altitude change.
- Altitude Hold will initiate an immediate level off. Pushing the switch will initiate the level off to the altitude where the switch was pushed.

AUTOFLIGHT DURING CRUISE

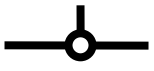
- **HDG SEL** or **TRK SEL** are available.
- **HDG/TRK HOLD** switch. When selected it rolls wings level then maintains the HDG/TRK.
- With **LNAV** selected it will engage if within **2.5 nm** of the active leg. If the aircraft is greater than **2.5 nm** from the active leg it will arm.
- There are 2 ways of disconnecting the Autothrottles.
    - Position the Autothrottle sws to OFF.
        - None of the A/T modes are available, nor is the A/T available for speed protection.
    - Push the Autothrottle disconnect sw.
        - The A/T remains armed and is available for speed protection.
- Selecting **FLCH**, **VNAV**, or **TO/GA** engages the autothrottle, or select the **A/T** sw on to engage the A/T in the currently engaged pitch mode.
- Pushing the A/T switch will disengage the A/T and give an EICAS Caution Message. Pushing it a second time cancels the EICAS Caution Message.

AUTOFLIGHT DURING DESCENT

- If within **50nm** of the TOD selecting a lower altitude and pushing the Altitude Selector will initiate a **DES NOW**. The airplane will descend at approx 1250 fpm until intercepting the Descent Path.
- At TOD or intercepting the VNAV PATH Thrust will change to IDLE then to HOLD.
- The aircraft will not descent through the MCP altitude. It will change to VNAV ALT.
- Pushing the Altitude selector will also delete Altitude Restrictions on the LEGS page.
- The airplane flies a descent path direct to waypoint altitude restraints.
- When V/S is selected a bug displays on the V/S indicator.

AUTOFLIGHT DURING GO-AROUND

- G/A arms when G/S captures or the Flaps are extended, there is no annunciation when G/A arms.
- Pushing the TO/GA sw initiates the G/A. AT engage in THR and set for a **2,000 fpm** climb.
- Pushing the TO/GA sw a second time will engage full TO/GA thrust.
- When G/A is initiated the F/Ds appear even if the F/D sws are off.
- TO/GA annunciates for Roll and Pitch.
    - Roll controls to maintain current track.
    - Pitch controls either the MCP speed or the speed at go-around initiation, whichever is greater. If either of these speeds are exceeded for more than **5 seconds** the current speed becomes the target.
- Above **400 feet** roll and pitch modes become available.
- When FPA is Selected the Selected FPA displays on the MCP and the PFD.



Flight Path Vector

= = Selected Flight Path

AUTOPILOT NON-NORMALS

- The **AUTOPILOT DISC** warning message displays when the Autopilots disconnect.
- If the Autopilots sense a failure in one of their components, all the engaged autopilots disengage.
- After an autopilot disconnect you may re-engage the system, all available A/Ps will re-engage.
- The **AUTOPILOT** caution message displays when the Autopilots are operating in a degraded mode.
- This will occur when Roll mode lost, Pitch mode lost, Overspeed, Stall, or bank angle protection.

AUTOTHROTTLE NON-NORMALS

- The **AUTOTHROTTLE DISC** caution message displays when a failure is detected in the A/T system.
- After an A/T disconnect you may attempt to re-engage the A/T system.
- The **AUTOTHROTTLE L/R** advisory message displays when an A/T servo failure is detected while the A/T system is engaged. This message will also display when one A/T sw is armed and the other is not.
    - A failure in either system will disconnect both A/Ts and display the **AUTOTHROTTLE DISC** caution message.
    - After the disconnect you may re-engage the A/T to operate the remaining servo.

AUTOLAND NON-NORMALS

- The **NO LAND 3** caution message displays when the autoland system does not have the redundancy for triple channel operation. This message displays when the system fails after the **LAND 3** is annunciated. The autoland is Fail Passive; another failure will render the system inoperative.
- The **NO LAND 3** advisory message displays when the autoland system does not have the redundancy for triple channel operation. This message displays when the system fails prior to the **LAND 3** or **LAND 2** status annunciation. The autoland is Fail Passive; another failure will render the system inoperative.
- The **NO AUTOLAND** caution message displays when a system failure prevents an autoland from being performed. This message displays when the system fails after the **LAND 3** or **LAND 2** status annunciation.
- The **NO AUTOLAND** advisory message displays when a system failure prevents an autoland from being performed. This message displays when the system fails prior to the **LAND 3** or **LAND 2** status annunciation.

AUTOPILOT ..... Caution Message with Beeper

CONDITION:

- Autopilot is in a degraded mode. Engaged roll and / or pitch mode may have failed, or the autopilot has entered envelope protection.

NOTES:

AUTOPILOT DISC ..... Warning Message with Siren

CONDITION:

- The autopilot has disconnected

NOTES:

AUTOTHROTTLE DISC ..... Caution Message with Beeper

CONDITION:

- Both Autothrottles have disconnected

NOTES:

AUTOTHROTTLE L, R

CONDITION:

- Affected autothrottle is off or has failed

NOTES:

NO AUTOLAND ..... Caution Message with Beeper

CONDITION:

- Autoland is not available

NOTES:

NO LAND 3 ..... Caution Message with Beeper

CONDITION:

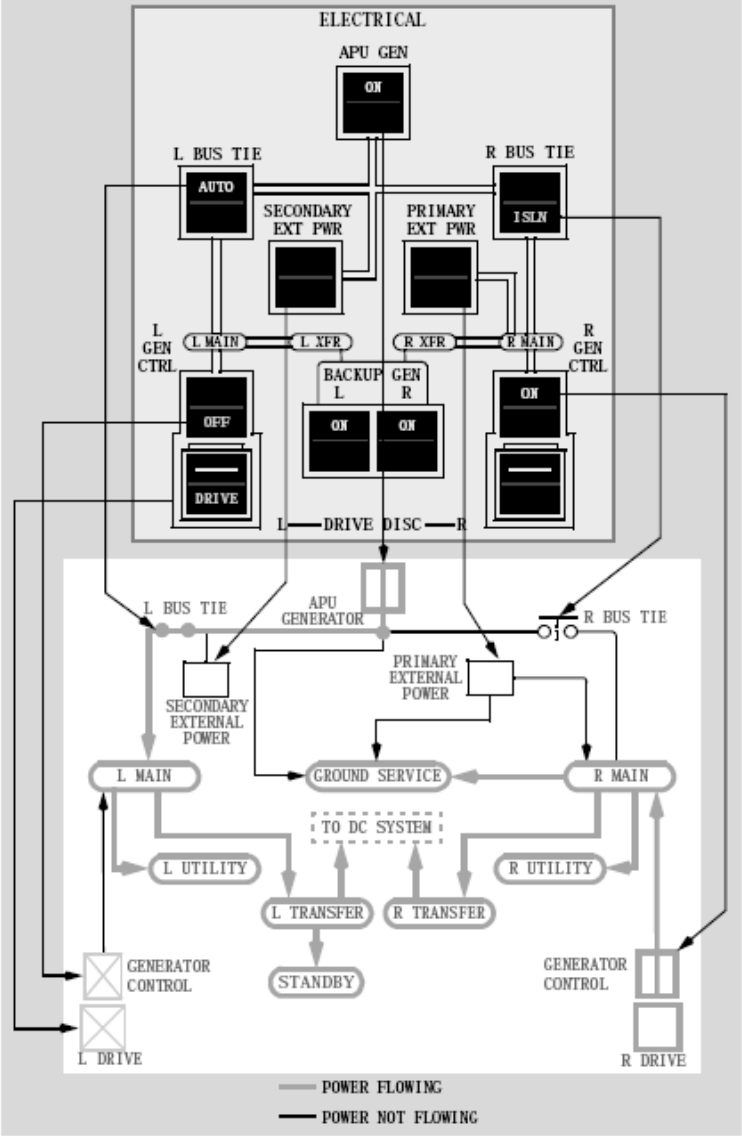
- Autoland system does not have redundancy for triple channel Autoland

NOTES:

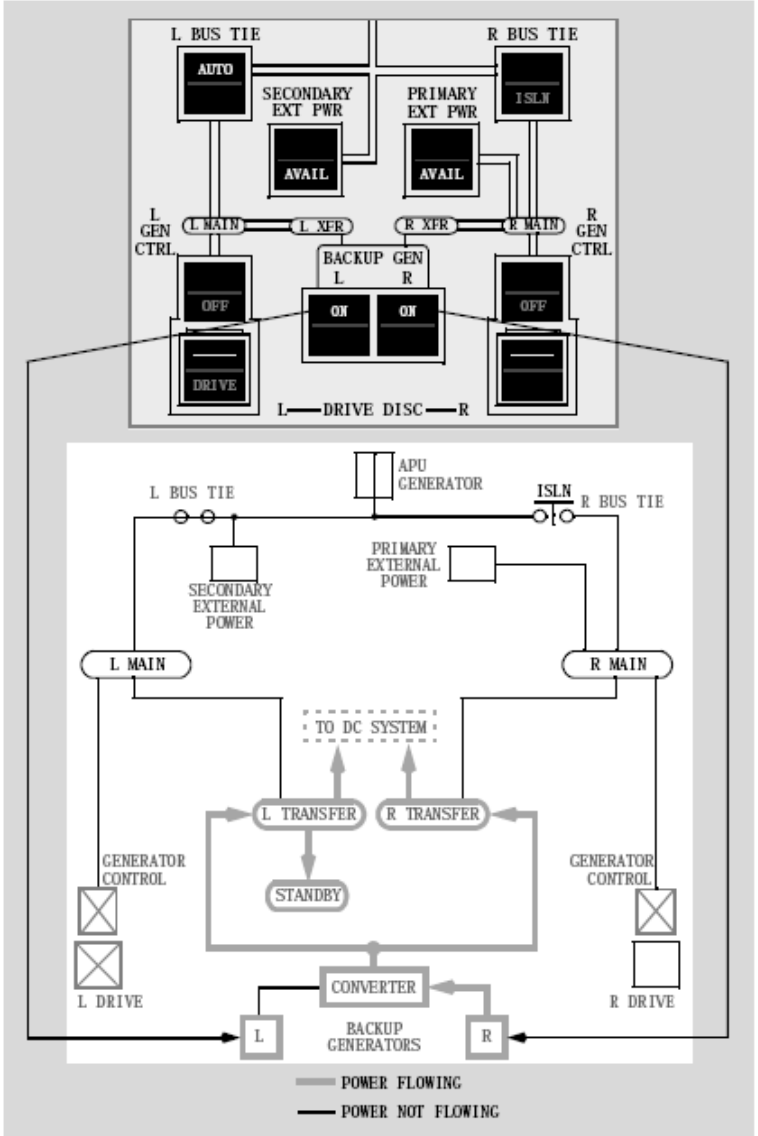
5. Communication & Datalink Systems

6. Electrical Systems

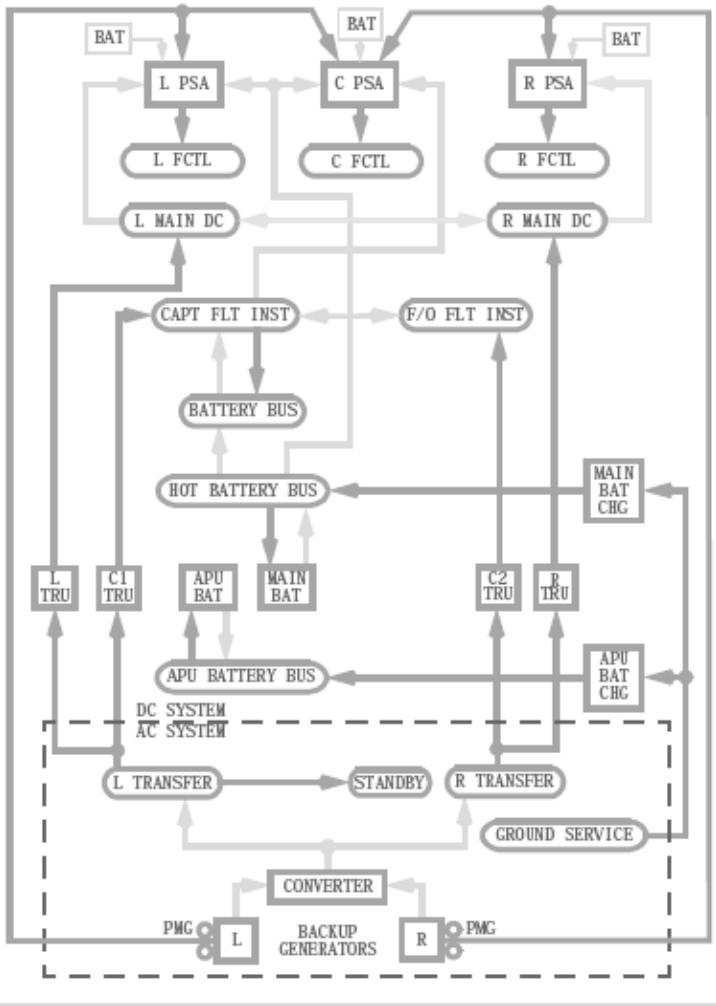
AC Electrical System Schematic



Backup AC Electrical System Schematic



DC and Flight Control Electrical Systems Schematic



PRIMARY POWER

ALTERNATE/STANDBY/BACKUP POWER

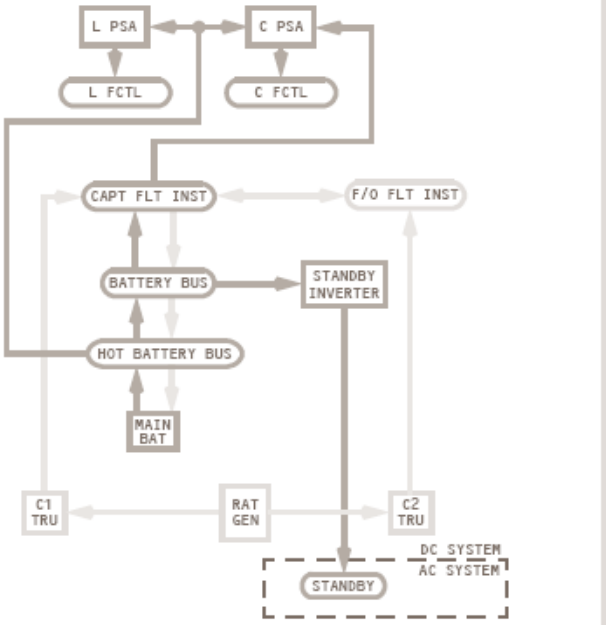
FCTL -- FLIGHT CONTROL DC BUS

FLT INST -- FLIGHT INSTRUMENT BUS

BAT CHG -- BATTERY CHARGER

PSA -- POWER SUPPLY ASSEMBLY

Standby Electrical System Schematic



STANDBY POWER (BATTERY ONLY AVAILABLE).

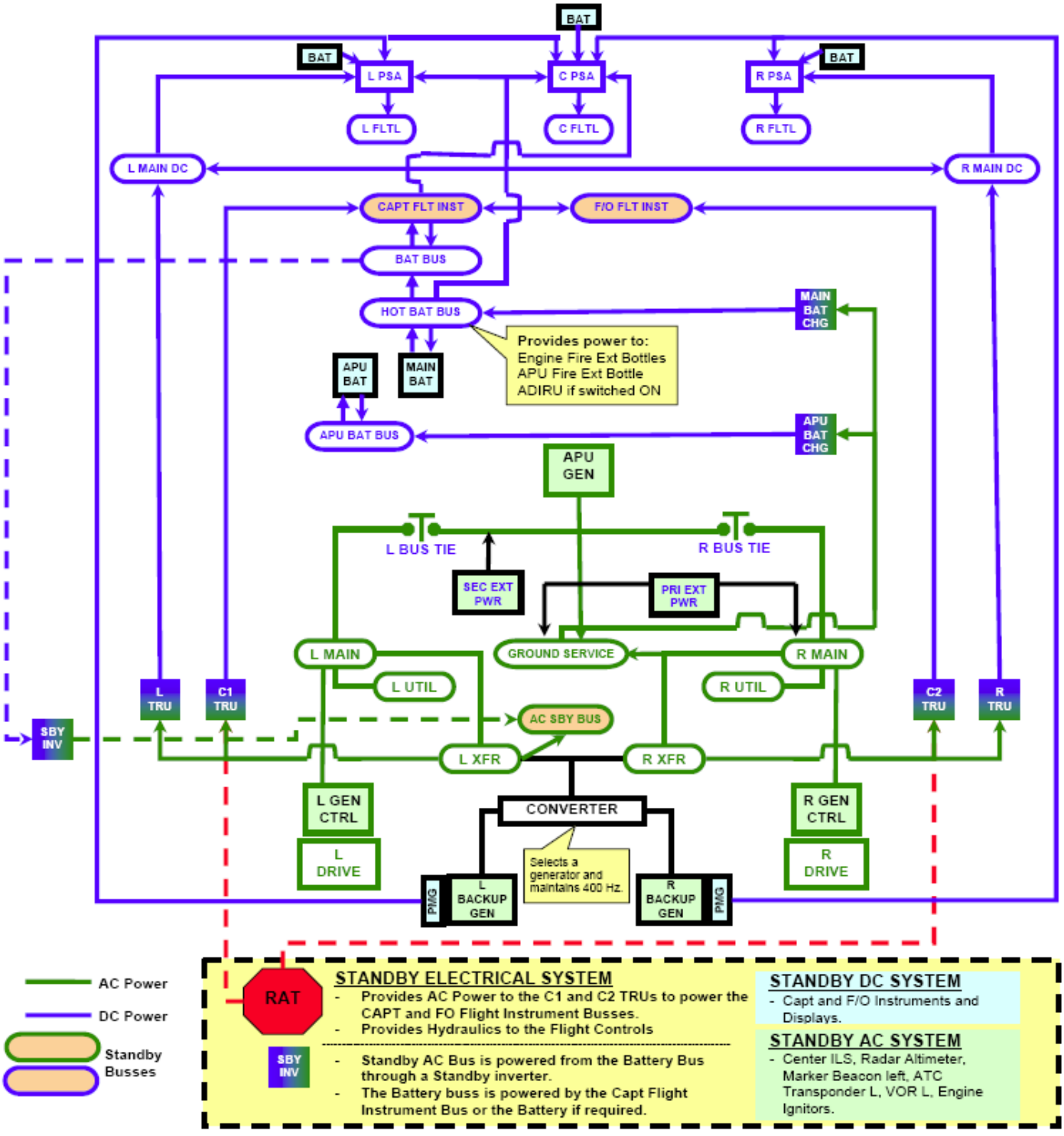
ADDITIONAL STANDBY POWER (RAT GEN AVAILABLE).

RAT GEN -- RAM AIR TURBINE GENERATOR

FCTL -- FLIGHT CONTROL DC BUS

FLT INST -- FLIGHT INSTRUMENT BUS

PSA -- POWER SUPPLY ASSEMBLY


BAT
BAT
L PSA
C PSA
R PSA
BAT
L FLTL
C FLTL
R FLTL
L MAIN DC
R MAIN DC
CAPT FLT INST
F/O FLT INST
BAT BUS
HOT BAT BUS
MAIN BAT CHG
Provides power to:
Engine Fire Ext Bottles
APU Fire Ext Bottle
ADIRU if switched ON
APU BAT
MAIN BAT
APU BAT BUS
APU BAT CHG
APU GEN
L BUS TIE
R BUS TIE
SEC EXT PWR
PRI EXT PWR
L MAIN
GROUND SERVICE
R MAIN
L UTIL
R UTIL
L TRU
C1 TRU
C2 TRU
R TRU
SBY INV
AC SBY BUS
L XFR
R XFR
L GEN CTRL
CONVERTER
R GEN CTRL
L DRIVE
Selects a generator and maintains 400 Hz.
R DRIVE
PMG
L BACKUP GEN
R BACKUP GEN
PMG
AC Power
DC Power
Standby Busses
RAT
SBY INV
STANDBY ELECTRICAL SYSTEM
- Provides AC Power to the C1 and C2 TRUs to power the CAPT and FO Flight Instrument Busses.
- Provides Hydraulics to the Flight Controls
- Standby AC Bus is powered from the Battery Bus through a Standby inverter.
- The Battery buss is powered by the Capt Flight Instrument Bus or the Battery if required.
STANDBY DC SYSTEM
- Capt and F/O Instruments and Displays.
STANDBY AC SYSTEM
- Center ILS, Radar Altimeter, Marker Beacon left, ATC Transponder L, VOR L, Engine Ignitors.

- For normal in flight operations all required power is provided by 2 engine driven generators.
- A 3rd generator driven by the APU is available in flight and is equal in size and capacity to either engine driven generator.
- Any 2 of these 3 generators meet all electrical requirements.
- Any one generator powers all essential flight loads.
- With only 1 generator available an Electrical Load Management System **ELMS**, automatically shuts down some low priority items, such as galleys.
    - Galleys and galley chillers.
    - Left and right utility busses.
- 2 main busses, Left and Right, distribute power to all airplane systems.
- A bus tie and 2 Isolation relays operate automatically to ensure both main busses remain powered at all times.
- The Hot Battery Buss provides power to the:
    - Engine Fire Extinguisher Bottles.
    - APU Fire Extinguisher Bottles.
    - ADIRU if it is switched on.

GROUND HANDLING BUS

- Is powered only on the ground by the Primary External Power or the APU only.
- It is used for cargo door operation, fueling defueling valves, cargo compartment doors, and maintenance access lights.
- Cabin lights can be powered by this bus if the switch at 1L is on.

GROUND POWER

- On Ground the Power Source Priority is
    - Respective Engine Generator
    - APU
    - Opposite Engine Generator
- Selecting External power to ON will cause both generator breakers to open.

BACK UP POWER SYSTEM

- Essential Loads are powered by the L and R Transfer Busses.
- Essential items include:
    - Instrument and panel lighting,
    - Captain's and F/O's navigation and communication radios,
    - Center pitot and engine probe heat.
- Transfer busses connect to one of the backup generators when their AC busses are unpowered.
- Backup generator switching is automatic when the switches are in the ON position.
- The Backup power system provides an uninterrupted transfer of power to the Transfer Busses in the event of:
    - loss of 1 main AC Bus,
    - The loss of both main AC busses,
    - When only one main generator is available,
    - and during Autoland.

STANDBY POWER SYSTEM

- The Standby System consists of the Battery Busses, the Captain's and F/O's Flight Instrument Busses, and an AC Standby Bus.
- Normal power for these busses is from the left and right AC Transfer Busses. Either directly or through TRUs.
- Should the Transfer buss become unpowered, A RAT will provide power through the TRUs and the Standby AC bus will be powered from the battery through a standby inverter.
- The RAT can be deployed in flight to provide electric and hydraulic power simultaneously. It is the primary sourse of standby electric power if all normal sources are lost.
- The RAT generator only provides 1/10 the power of a regular generator. It will deploy automatically if both Transfer busses are unpowered, or if all 3 hydraulic system pressures are low, or with dual engine failure and the center hydraulic system pressure low.
- The Green Press light in the RAT switch illuminates when the hydraulic pressure is adequate.
- The RAT gives priority to the Hydraulic system and will shed electrics if the hydraulic pressure drops. The Main battery powers the standby system during this time.
- When the RAT is supplying electrics both Flight Instrument busses are powered. When the Battery is supplying power, only the Captains Flight instrument bus is powered.

ABNORMALS

- Low IDG oil pressure will cause an EICAS Message **ELEC GEN DRIVE L** the drive must be manually Disconnected.

- High generator oil temperature automatically disengages the drive and gives EICAS messages:
  ELEC GEN OFF L **ELEC GEN DRIVE L**
- Autoland is possible with one main generator and one backup generator operating.

□ ELEC AC BUS L, R ..... Caution Message with Beeper

CONDITION:

- AC Bus is unpowered

REASON:

CHECKLIST:

NOTES:

□ ELEC BACKUP GEN L, R

CONDITION:

- Backup generator has failed

REASON:

CHECKLIST:

- Only one Reset attempt can be made by cycling the Backup Gen Switch off then on

NOTES:

□ ELEC BACKUP SYS

CONDITION:

- Backup power system has failed

REASON:

CHECKLIST:

NOTES:

ELEC BATTERY OFF

CONDITION:

- Battery Switch is off

REASON:

CHECKLIST:

NOTES:

ELEC BUS ISLN L, R

CONDITION:

- Bus Tie Breaker is open due to an AC electrical system fault or Bus Tie Isolation Switch is off

REASON:

CHECKLIST:

NOTES:

□ ELEC GEN DRIVE L, R

CONDITION:

- Backup power system has failed

REASON:

CHECKLIST:

NOTES:

□ ELEC GEN OFF APU

CONDITION:

- Backup power system has failed

REASON:

CHECKLIST:

NOTES:

□ ELEC GEN OFF L, R

CONDITION:

- Backup power system has failed

REASON:

CHECKLIST:

NOTES:

ELEC GND HDLG BUS

CONDITION:

- Ground handling bus relay has failed

REASON:

CHECKLIST:

NOTES:

ELEC STANDBY SYS

CONDITION:

- A fault is detected in the standby power system

REASON:

CHECKLIST:

NOTES:

MAIN BATTERY DISCH

CONDITION:

- Main battery is discharging or hot battery bus is unpowered

REASON:

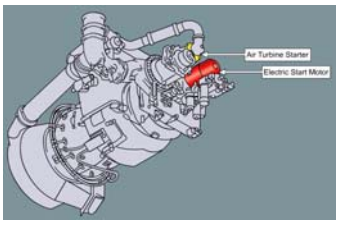
CHECKLIST:

NOTES:

INTENTIONALLY BLANK

7. Engines & APU Systems

APU Operations FCOM 7.30.2



APU Starting

- Starter selection is automatic. The air turbine starter has priority over the electric start motor when duct pressure.
- **Air Turbine:**
  - The air turbine starter uses engine bleed air or ground cart air to start the APU.
- **Electric:**
  - The electric starter is powered by the APU battery.
  - The main airplane battery powers the inlet door, fuel valve, and fire detection system.
- **Sequence:**
  - The inlet door opens
  - APU fuel is supplied from the left fuel manifold by any operating AC fuel pump or the DC fuel pump.
  - With AC power available and the APU selector in the ON position, the left forward fuel pump operates automatically.
  - If AC power is not available or no AC pump pressurizes the left fuel manifold, the DC pump in the left main tank provides APU fuel.
  - On the ground, the APU can be started with no pumps operating.
  - When the APU inlet door reaches the full open position the starter engages.
  - After the APU reaches the proper speed Ignition and fuel are provided.
  - When the APU reaches 50% RPM the starter disengages and the ignition is turned off.
  - APU RUNNING is displayed when the APU is operating normally.
- **Automatic:**
  - If the start fails The APU shuts down automatically. The ECAS Message ▫ APU SHUTDOWN is displayed.
  - In flight if both AC transfer busses lose power, the APU automatically starts, regardless of the APU selector position. The APU can be shut down by positioning the selector to ON then OFF.

APU Attended Mode

The APU is running and the Engines are starting or running or the aircraft is in flight.

- Any of the following faults cause the APU to shut down immediately:
  - APU Fire/Inlet Over temperature
  - Over speed/Loss of over speed protection
  - APU Controller Failure
  - Speed Droop
- There is no cool down period. The EICAS advisory Message ▫ APU SHUTDOWN displays
- For the following faults the APU continues to operate and the EICAS message ▫ APU LIMIT displays
  - High EGT
  - High Oil Temperature
  - Low Oil Pressure
- There is no cool down limit when the APU is shutdown after the ▫ APU LIMIT message is displayed.

APU Unattended Mode

The APU is running and the Engines are shut down.

- In the unattended mode, any of the following faults cause the APU to shut down immediately:
  - APU Fire/Inlet Over temperature
  - Over speed/Loss of over speed protection
  - High EGT
  - High Oil Temperature
  - Low Oil Pressure
  - Generator Filter approaching Bypass
  - Intake door Failure
  - Speed Droop
  - No combustion on Start
  - No Acceleration on Start
- There is no cool down period.

APU Shutdown

- **Sequence:**
  - Rotating the APU to OFF starts the shutdown sequence.
    - The APU bleed valve closes.
    - The APU runs for a cooldown period… APU COOLDOWN
    - The APU shuts down.

APU Supplementary Procedures

- **APU Ground Pneumatic Start:**
  - Follow FCOM SP.1.7
  -

μ ABORTED ENGINE START L/R.

CONDITION:

- Start ***parameters exceeded*** e.g. no oil pressure at initial EGT rise.
- EGT rising rapidly ***approaching limit during manual start***
- ***Tailpipe fire*** is reported.

REASON:

CHECKLIST:

- **# Fuel Control switch - Cutoff.**
- If on the ground:
  - Start selector - Start (Motors engine for 30 seconds to expel unused fuel from the engine and cool the turbine).
  - Start selector - Norm.

NOTES:

- PF would then accomplish the recall item (Fuel control switch - cutoff) and then call for the **ABORTED ENGINE START CHECKLIST**.
- Don't rush to restart. Consider exceedences/ damage/ Reasons causing problem - e.g. no oil pressure due any oil quantity.
- Oil pressure and oil temperature is not monitored by the autostart system:
- *Oil pressure must begin rising by EGT rise. This may also lead to an aborted engine start*
- *Oil temperature must be above -40ºC for engine start*

□ APU LIMIT ..... Caution Message with Beeper

CONDITION:

- APU has exceeded a limit

REASONS:

- High EGT.
- High oil temperature.
- Low oil pressure.

CHECKLIST:

- APU selector - Off.

NOTES:

- For the above reasons there is no APU cool down period.
- If on the ground, consult the MEL. (Also consider ETOPS, APU required for an additional fault etc)
- If prior to engine start, consider accessing the QRH supplementary procedures for an **ENGINE GROUND PNEUMATIC START**. ***Next sector considerations***: is ground power available and ground cart for an air start available.

-

□ APU SHUTDOWN

CONDITION:

- APU has automatically shutdown

REASONS:

- APU fire / inlet over temperature.
- Over speed / Loss of over speed protection.
- APU controller failure
- Speed droop

CHECKLIST:

- APU selector - Off.
- APU selector - Start, release to On. ***[If APU is required??? How desperately???]***

NOTES:

- For the above reasons there is no APU cool down period.
- If APU is inoperative:
- If on the ground, consult the MEL. (Also consider ETOPS, APU required for an additional fault etc)
- If prior to engine start, consider accessing the QRH supplementary procedures for an ENGINE GROUND PNEUMATIC START. Next sector considerations: is ground power available and ground cart for an air start available.

DUAL ENGINE FAIL / STALL

CONDITION:

- Engine speed for both engines is below idle.

CHECKLIST:

- **# Fuel Control Switches (Both) - Cutoff, then Run.**
- **# Ram Air Turbine Switch - Push. Push and hold for 1 second.**
- Airspeed - above 250kts.
- APU selector (If APU available) - Start, release to on.
- Engines may accelerate to idle slowly. Slow acceleration may be incorrectly interpreted as a hung start or engine malfunction. Any further cycling of the fuel control switches will result in longer start times.
- When **HEAT PITOT L+C+R** message no longer displayed:
- PFC's disconnect switch - Disc, then Auto.
- Autopilot can be re-engaged when flight control normal mode is restored.

NOTES:

- ***CM1 " I have control". Fly the aircraft. Wings level and begin a driftdown - targeting >250kts. Pitch just below the horizon.***
- ***Turn towards nearest airfield.***
- **Accomplish Recall items**.
- Prior to RAT extension and automatic APU start, the main battery provides power to:
- Hot Battery Bus and Battery Bus. L and C flight control buses. Captains flight instruments (PFD, ND, standby instruments x3, EICAS, AND L.CDU) Standby Inverter.
- Loss of pitot heat causes flight control mode to revert to secondary mode which means:
- No autopilot, No TAC,and no flight envelope protection.
- Once **HEAT PITOT L+C+R** message disappears - recycle PFC switch to get Normal mode. (Use A/P, TAC etc)
- RAT deploys automatically if:
  - Both transfer buses lose power in-flight.
  - All 3 hydraulic system pressures are low.
  - Dual engine failure and C hydraulic system pressures are low.
- RAT powers:
  - The primary flight controls normally powered by the C hydraulic system.
  - Electrically powers the electronics that support the FBW flight controls i.e. The Standby Electrical System.
- With TRU's C1 and C2 powering the Captains and First Officers flight instrument buses, both PFD's and ND's, Standby instruments x3, EICAS and the L.CDU are powered.

- *NOTE: If the RAT is unable to maintain RPM, the electrical load is shed until RPM is satisfactory i.e. hydraulic power has priority. When electrical load is shed, the F/O's flight instrument bus is not powered.*
- APU starts automatically if both transfer buses lose power in-flight. Once APU is on line, the overhead panel is now lit and the FD and A/P can be used. (A/P requires flight controls to be in normal mode.)
- **Accomplish the Unannunciated DUAL ENG FAIL/STALL checklist.**
- ECL may not be available (use QRH) or checklists may not be correctly sequenced.
- **Engine relight:**
- Do not rush the Fuel Switches. Pauses between CUTOFF then RUN is necessary. (This repositions the IGV's. A stalled condition is cleared. EEC's are put into Start Mode. Computers are reset.)
- ***Engines*** may take a while to start, give them ***Time***. Cycling of Fuel Control Levers will result in even longer start times. Monitor engine parameters to see what the autostart is doing. **Once below FL300,** closely monitor engine instruments to see what's going on and consider recycling the fuel control switches to idle then run.
- Or if the APU is running try a cross bleed start by recall, cycle the fuel control switches to cut-off, select the engine start selector - Start and then put the fuel control switches to run.
- Engines are unlikely to start Symmetrically. Remember ***TAC may be OFF***. Use manual rudder inputs.
- Engines are at stable idle when the EGT start limit line disappears.
- The second engine may need to be started using the unannunciated ENG IN-FLIGHT START L/R checklist.
- Systematically do the checklists as required by EICAS, particularly the engine related ones such as EEC which may have caused the engine failure.
- A Cabin Altitude Warning may occur, do the sensible part of the recall items such as Masks - on and pax oxygen deploy. Don't do a rapid descent. Aircraft probably in the mid-20 000's anyway with cabin below 15000ft.
- **FMC:**Use for E/OUT performance information.
- May need to reactivate the route. (Blue dotted line if route inactive). Performance data may have been dumped.
- If APU does not start then Flaps are not available.

AUTOSTART.

This is the normal engine start procedure.

1. For: No N1 rotation, starter shaft failure, insufficient air pressure and starter duty cycle exceeded,
   - ❑ EEC aborts the start sequence without motoring.
   - ❑ Autostart does not make a 2nd start attempt.
2. For: A hot start, hung/compressor stall start or no light up **and** N3 RPM is ***less*** than starter cut-out speed:
   - ❑ EEC turns off fuel and ignition.
   - ❑ Motors the N3 for 30secs and for EGT to fall to below 100ºC.
   - ❑ Autostart makes a 2nd attempt using both igniters.

   N3 RPM is ***greater*** than starter cut-out speed:
   - ❑ EEC turns off fuel and ignition.
   - ❑ EEC closes the start valve, allows the N3 to drop to <10%.
   - ❑ EEC then reopens the start valve to motor the N3 for 30secs before reintroducing fuel and ignition.
   - ❑ Autostart makes a 2nd start attempt using both igniters.

- If the engine does not start/ the engine start is aborted on the second attempt, the EEC turns off fuel and ignition, closes the start valve and the N3 winds down whilst at the same time motoring the engine for 30secs. If the N3 has run down before the engine has sufficiently motored, the EEC spools up the N3 until sufficient motoring has taken place. This is then followed by the EICAS caution: **ENG AUTOSTART L/R**.
- Once the Engine Autostart recall items have been completed i.e. fuel control switch - cutoff, the EICAS caution message **ENGINE AUTOSTART** is replaced by an **ENGINE SHUTDOWN** advisory message. The checklist philosophy applies here; if you've done the recall items then you must do that checklist. The Engine Autostart checklist is in the non-normal checklist queue. **MEL!**
- **Note:** Autostart does *not* monitor oil pressure and oil temperature.
- Rough stable idle parameters: EPR - unity. N1 - 20%. EGT - <400ºC. N2 - 46%. N3 - 64%. FF - 0.8.

❑ ENG AUTOSTART L/R ..... Caution Message with Beeper

CONDITION:

- Autostart has failed to start the engine.
- *(This is irrespective of whether the problem is with the engine or the autostart system.)*

CHECKLIST:

- **# Fuel Control Switch - Cutoff.**
- Start Selector - Norm.

NOTES:

- Autostart has failed to start the engine.
- *This is irrespective of whether the problem is with the engine or the autostart system.*
- *PF would accomplish the recall items (fuel control switch to cutoff) and then call for the ENGINE AUTOSTART checklist. Note: once the recall items have been completed the EICAS message ENG AUTOSTART L/R is replaced by ENGINE SHUTDOWN L/R.*
- *All crew need to do is turn fuel control switches to cutoff. The autostart has done the motoring of the engine if required.*
- There is no point in carrying out a manual start if you determine from the engine parameters during start that there is a problem with the engine. Apart from when the autostart system itself fails, pull back into the bay. Don't try another attempt or a manual start. Get the engine looked over.

ENG AUTOSTART OFF

CONDITION:

- Engine Autostart Switch is off

NOTES:

- Dispatch with Autostart Off will mean the following:
  - o Autostart will not monitor the temperature during an In-Flight and discontinue the start if Takeoff EGT is reached or there is no light off or a hung start
  - o It will not make continuous start attempts
  - o It will not control EGT to 200 before re-introducing fuel on a second attempt
  - o It will not introduce the fuel at the best schedule
  - o The EEC's will provide Flameout and Auto Re-light if they are working

ENG CONTROL L, R

CONDITION:

- Fault is detected in the affected engine control system

REASON:

CHECKLIST:

NOTES:

□ ENG EEC MODE L, R

CONDITION:

- Control for the affected engine is operating in alternate mode.

REASON:

CHECKLIST:

- Autothrottle disconnect switch - Push.
- Thrust levers (Both) - Retard to mid position. *[Prevents exceeding thrust limits when switching to alternate mode].*
- EEC mode switches (Both) - OFF. Push one switch at a time.
- Autothrottle engage switch - push.
- Note: Maximum thrust limiting is not available with autothrottle disconnected. Alternate thrust setting information is displayed on N1 indications.

NOTES:

- At Dispatch:
  - **EICAS Status Messages:** **ENG EEC MODE L, R**
  - **MEL ITEMS:**
  - 30-34-1 Engine PT2/TT2 Probe Heater Systems
  - 73-21-2 Electronic Engine Controls (EEC) Normal Mode
- **Main points:**
  - De-Rated and / or reduced thrust takeoffs are not allowed.
  - Dispatch in accordance with the AFM Alternate EEC mode operation appendix. Performance for operating with the EEC's in alternate mode can be found in the Emirates FCOM Performance In-flight chapter.
  - MEL
  - Calculate the RTOW for the current conditions with EK RTOW orange tables e.g. RTOW 260T.
  - QRH - ALTERNATE EEC
  - Alternate Mode EEC limit weight
  - In the right hand box under primary mode performance limit weight (1000kgs) find **260.**
  - Slide vertically down the various limits i.e. field/climb/obstacle/etc and find the **lowest weight.**
  - In this example it is 249.7 - Obstacle limit. This is the **revised RTOW.**
  - Alternate Mode EEC Takeoff Speed Adjustment:
  - Adjust the **actual speeds** by the tabulated adjustment.

- In Flight:
  - When the EEC automatically switches to the alternate mode (soft alternate mode) the EPR indication is blank and no thrust reference is available.
  - Selecting both EEC's to OFF, as directed by the checklist, puts the EEC's into the hard alternate mode. This eliminates throttle stagger.
  - Reference and target N1 and max / min values are displayed on the N1 indication. These values are computed by the FMC.
  - Thrust limit protection is not available and maximum thrust can be achieved at thrust lever positions less than full forward. If the thrust lever position commands an N1 greater than max rated thrust, the EICAS caution message ENG LIMIT PROT L/R will display. The caution message prompts you to reduce the thrust.
  - N1, N2 & N3 overspeed / red line protection is still available. If the EEC is trimming the fuel flow to provide overspeed protection the EICAS advisory message ENG RPM LIMITED L/R is displayed.
  - Dispatch - MEL. A performance penalty is incurred when dispatching with the EEC's inoperative. Calculate the RTOW from the performance tables and then make the make the adjustments to the RTOW and the speeds from the QRH - Performance In-flight section - Alternate Mode EEC.

ENG FAIL L/R ..... Caution Message with Beeper

CONDITION:

- Engine speed is below idle.

CHECKLIST:

- The checklist procedure leads you through an engine shutdown.
- Restart may be attempted if no apparent damage.
- Checklist procedure leads you through a cross bleed or windmill restart depending on the start envelope.
- If engine damaged or remains failed:
- ***Plan to land at nearest suitable airport.***
- Land using flaps 20 or flaps 30 (performance permitting - check the Landing Climb Limit Weight chart),

NOTES:

- The EICAS caution message ENG FAIL L/R is displayed whenever an engine unexpectedly decelerates below idle speed. The message remains displayed until the engine recovers or the fuel control switch is moved to Cutoff.
- For the engine that just flames out / runs down - there are no recall items. Perform the ENG FAIL non-normal checklist to be at the appropriate time.
- See our notes on engine restarts.

□ ENG FUEL FILTER L/R

CONDITION:

- An impending fuel filter bypass condition exists on the affected engine.

REASON:

- The fuel filter may be clogging due to contaminated fuel

CHECKLIST:

- Note: Erratic engine operation and flameout may occur due to fuel contamination.

NOTES:

- The fuel filter is downstream of the spar fuel valve and the fuel / oil heat exchanger. The fuel then flows through a fuel filter, which removes contaminants.
- Consider the implications of an engine flameout ***if*** one should occur i.e. routing / terrain / suitable airports / weather etc.
- Should the occurrence of the ***'if'*** put you in a difficult situation with limit options then consider diverting.
- Consult engineering for additional information.
- If fuel is contaminated on one engine then it is possible that the whole fuel uplift is contaminated. A landing should be made as soon as practical if this is suspected
- Consider the implications of cross feeding if contamination is suspected in the tank

□ ENG FUEL VALVE L/R

CONDITION:

- Engine or spar valve position disagrees with commanded position.

CHECKLIST:

- If **ENG FUEL VALVE L/R** message is displayed when the fuel control switch is positioned to Cutoff, the engine may continue to run for approximately 1 minute.
- If on the ground: do not attempt engine start. *[Prevents possibility of not being able to shutdown the engine if both valves subsequently fail open.]*

NOTES:

ENG IDLE DISAGREE

CONDITION:

- One engine is at approach idle and the other engine is at minimum idle.

NOTES:

- Approach idle decreases acceleration time for go-around.
- Approach idle is selected in-flight if:
  - Engine anti-ice is operating
  - The flaps are commanded to 25 or greater
  - One hydraulic system air driven demand pump is inoperative, and the flaps are out of the UP position or
  - The opposite engine bleed air valve is closed. (Takes care of the engine inoperative case).
- Approach idle is maintained until after touchdown, when minimum idle is selected.

μ ENGINE INFLIGHT START

CONDITION:

- Engine start is desired after a shutdown with no fire or apparent damage.

CHECKLIST:

- Monitor EGT during start.
- If X BLD is displayed: accomplish a cross bleed start. If the autostart is off, position fuel control switch to run at maximum motoring.
- If X BLD is not displayed: accomplish a windmill start.
- Note: Engine may accelerate to idle slowly. Slow acceleration may be incorrectly interpreted as a hung start or engine malfunction.

NOTES:

- Accomplish the engine restart procedure as part of the **ENG FAIL L/R** ECL or access the ENGINE or UNANNUNCIATED non-normal menu and select **ENG IN-FLIGHT START L/R**.
- Do **not** restart for engine fire, obvious bangs and surging, severe damage and exceedences.
- N1 must be above zero otherwise the engine has seized. N2 should be nominal but above zero. N3 is zero unless the engine is running. Oil quantity not low. Check all engine instruments.
- The 2nd engine page pops up when: an exceedence has occurred, fuel control s/w in cut-off in flight, an engine fire s/w is pulled in flight and also when N3 is below idle in flight.
- If the ECL is on the lower MFD then EICAS has compact engine display. EGT and N3 are in digital form, which will be boxed amber or red if an exceedence has occurred.
- The EGT start limit is displayed when the fuel control s/w is in cut-off or N3 rpm is below idle. This is displayed as a red line on the normal display or a red 700 abeam the EGT on compact display. The EGT start limit disappears when the engine is at stable idle.
- Accomplish a cross bleed start as per the ECL instructions. Start must be selected on the Start selector. Putting the fuel control s/w activates the autostart. If autostart is off, select run at max motoring N3. Keep your hand on the Fuel Control s/w so that you can abort the start if necessary. Autostart temporarily aborts the start at the T/O EGT (900°C). **The pilot must abort start at the Start EGT limit of 700°C**.
- Monitor: N3 windup. Fuel - flow shortly after max motoring N3. EGT rising shortly after fuel - flow indication.
- N1 and oil pressure rise. Ensure that there are no exceedences or vibration.
- Monitor oil temperature changing/increasing from amber/white as the engine warms up. When the engine has started and warmed up, advise the PF and turn the respective A/T arm s/w to arm. This will advance thrust while retarding the other until both are symmetrical. If the TAC is off, the PF ask PNF to cancel redder trim
- FMC - activate the ALL ENG prompt for all engine performance predictions and for continued VNAV use.

□ ENG LIMIT PROT L/R ..... Caution Message with Beeper

CONDITION:

- Engine control is operating in ***alternate mode*** and commanded N1 exceeds maximum N1.

CHECKLIST:

- Thrust lever - Retard
- Retard until N1 remains within appropriate limits.

NOTES:

- Thrust limit protection is not available and maximum thrust can be achieved at thrust lever positions less than full forward. If the thrust lever position commands an N1 greater than max rated thrust, the message **ENG LIMIT PROT L/R** will display. The caution message prompts you to reduce the thrust.

µ ENGINE LIM / SURGE / STALL L, R

CONDITION:

- Engine ***Indications are Abnormal***
- Engine Indications are ***Approaching*** or ***Exceeding Limits***
- Abnormal Engine ***Noises*** are heard
- There is no response to ***thrust lever movement***

REASON:

- Many and varied

CHECKLIST:

- ***Retard*** the Thrust Lever
- If the indications are still ***abnormal*** or ***EGT continues to increase***: Then shutdown and ***Land at nearest suitable airport***
- If the indications stabilised or EGT decreasing: Advance Thrust Lever to a useable level
- Decide on Flap setting to use 20 or 30

NOTES:

- If engine is still exceeding limits or surging badly when the recall items are completed, consider calling for the ENG SVR DAMAGE / SEP L, R recall
- Even is engine has not been shut down consider using a flap 20 landing for limited available thrust on G/A

□ OIL PRESS L/R ..... Caution Message with Beeper

CONDITION:

- Engine Oil Pressure is low

REASON:

CHECKLIST:

- Operate the engine at idle (Thrust lever - Close) or if the **ENG OIL PRESS** message remains illuminated then shutdown the engine
- If engine is shutdown, ***Land at nearest suitable airport.***

NOTES:

- Is a caution level alert. Definition - requires immediate crew awareness, corrective action may be required.
- Bear in mind though that timely action is required if engine is operating at high thrust levels (engine may seize without oil pressure). Situation management required - fly the aircraft first.
- When accelerating, flaps retracted, A/P engaged and PF able to handle extra workload, call for the **OIL PRESS L/R** checklist.
- If engine fails violently prior to shutting down the engine, may end up performing the **ENG SVR DAMAGE/SEP** recall items and checklist.

□ ENG OIL TEMP L, R

CONDITION:

- Engine Oil temperature is high

REASON:

CHECKLIST:

- Move the Thrust Lever to a ***Mid Position***
- If the Oil Temperature is above the Red Line limit then shut the engine down and ***Plan to land at the nearest suitable airport***

NOTES:

ENG REV LIMITED L, R

CONDITION:

- Engine Thrust Reverser will not deploy or reverse thrust will be limited to idle on landing

REASON:

CHECKLIST:

NOTES:

- Observe that crosswind limits on ***Wet*** or ***Contaminated*** runways are reduced by 5 Kts
- With additional faults, the Non Normal Configuration landing distances may be invalid

ENG REVERSER L, R

CONDITION:

- Fault is detected in the affected engine Reverser system

REASON:

CHECKLIST:

NOTES:

ENG RPM LIMITED L, R

CONDITION:

- Engine control is limiting affected engine thrust to prevent N1 N2 or N3 from exceeding the RPM operating limit

REASON:

CHECKLIST:

NOTES:

- The engine is in alternate mode
- Thrust limit protection is not available and maximum thrust can be achieved at thrust lever positions less than full forward.
- N1, N2 & N3 overspeed / red line protection is still available, however. If the EEC is trimming the fuel flow to provide overspeed protection the EICAS advisory message **ENG RPM LIMITED L/R** is displayed.
- If the thrust lever position commands an N1 greater than max rated thrust, the EICAS caution message **ENG LIMIT PROT L/R** will display. The caution message prompts you to reduce the thrust.

ENG SHUTDOWN

CONDITION:

- Both engines were shutdown on the ground by the fuel control switched or fire switches

CHECKLIST:

NOTES:

ENG SHUTDOWN L, R

CONDITION :

- Engine was shutdown by the fuel control switch or fire switch

CHECKLIST:

NOTES:

ENG START VALVE L, R

CONDITION:

- Engine start valve is closed when commanded open.

REASON:

CHECKLIST:

- If on the ground: Fuel control is put to cut-off and start selector is put to normal as the start is not possible
- If in flight: Cross bleed start is not possible so airspeed must be increased

NOTES:

- Accomplish the Non-Normal ECL. Check STATUS. Consult MEL for dispatch relief.
- *Consult EK engineering/engineer to determine if a Manual Override Engine Start is desired or if maintenance action should be taken. Consider down route facilities if you decide to continue.*
- **MANUAL OVERRIDE ENGINE START** S.P. Accomplish the drill by reference to the Supplementary Procedures. The ground crew needs to manually open and close the start valve when directed to by the CM1. Establish good communications.
- Remember that the Autostart will start the engine
- If the engine subsequently has start problems (Autostart - on), suggest aborting the engine start as this is the valve the Autostart uses to deal with problems.

ENGINE STARTER CUTOUT L/R ..... Caution Message with Beeper

CONDITION:

- Start/ignition selector remains in START or
- Engine start valve is open when commanded closed.

REASON:

CHECKLIST:

- Start selector - Normal (This deals with condition)
- If **ENG STARTER CUTOUT** message remains displayed: (This part of the checklist deals with condition).

NOTES:

- Checklist steps lead to removing the bleed source from the starter.
- Consult MEL.
- Is it wise to dispatch in this condition?
- Avoid icing conditions & Engine cross bleed start is not available due to isolation valve closed.

ENG SVR DAMAGE/SEP L/R.

CONDITION:

- Engine has Severe Damage, Vibration or has Separated

REASON:

- Internal failure or FOD

CHECKLIST:

- Close Thrust Lever, Fuel Control Switch and pull Fire Switch by recall
- Start APU and ***Plan to land at nearest suitable airport***

NOTES:

- Where an engine is exceeding limits and vibrating slightly but still delivering power, it may be prudent to do the ENG LIMIT/SURGE/STALL Recall first. This may control the vibration. If it still persists continue with the ENG SVR DAMAGE/SEP Recall.
- It may be difficult to identify which engine is causing the problem if both are delivering power but there is heavy vibration.
- This checklist will also address the case where High Vibration continues after shutdown. This it does by attempting to ***reduce the TAS*** by ***slowing*** and ***descending***. If slowing is not practical, it suggests increasing the speed to get out of the vibration realm. See FCTM 1.30
- If there is high airframe vibration from an engine failure, it is extremely unlikely that this will damage the aircraft or systems even though it seems extreme

ENG THRUST L/R ..... Caution Message with Beeper

CONDITION:

- The Engine is not producing commanded Thrust.

REASON:

CHECKLIST:

NOTES:

VOLCANIC ASH

CONDITION:

- The airplane is in volcanic ash.
  - **Indications:**
    - Acrid Smell (Like electrical burning) (Sulphurous)
    - Smoke thru Aircon System
    - St Elmo's Fire
    - Bright magnesium type light in Engine inlets
    - Engines Flameout / Surge or Stall
    - Cargo Fire Warning
    - ASI misreading
    - Equipment Cooling Override (Equipment Overheating)
    - Lav Smoke
    - Communication Problems
    - Window Opaqueness
    - Ash Reports
  - **Damage:**
    - Engine Blade Erosion
    - Molten Deposits
    - Cooling drilling blockage
    - Fuel Nozzle clogging
    - Engine Choking
    - Pitot/ Static clogging
    - Leading Edge pitting
    - Windshield and Light Lens Opaqueness

REASON:

CHECKLIST:

- Exit volcanic ash as quickly as possible. ***Consider a 180º turn***.
- ***A/T disconnect*** switch push.
- ***Thrust levers - close***. (Conditions permitting, operate engines at idle. Reduces engine damage / flameout by decreasing EGT.) (Higher EGT's result in more ash content melting onto the engine parts – 75% of the ash will not melt at IDLE EGT's
- ***Engine & wing anti - ice selectors - ON***. (Increases bleed air extraction to improve engine stall margin)
- ***Recirculation fans - OFF*** (Increases bleed air extraction to improve engine stall margin by putting packs into high flow.)
- **Do the above by recall if possible.**
- APU - Start, release to on. (Provides an electrical power source if engines fail).
- Non -normal system reactions include: engine malfunctions, increasing EGT, engine stall / flameout, decrease or loss of airspeed indications, equipment cooling override indications and fire cargo fwd / aft indications.
- If engines flamed out or stalled, or EGT rapidly approaching or exceeding limit:
- Fuel Control switches (both) - Cutoff, then Run. (Attempts to clear the stall condition and puts engine in start mode).
- RAT - push and hold for 1 second.
- Airspeed - **Above 250 knots** (ensures best windmill start capability).
- Pitch attitude required is **0º ND**.
- Engines may accelerate to idle slowly. Slow acceleration may be incorrectly interpreted as a hung start or engine malfunction. Any further cycling of the fuel control switches will result in longer start times.

- When **HEAT PITOT L+C+R** message no longer displayed:
  - PFC's - Disc, then Auto. (Restores flight control normal mode following reversion to secondary mode caused by loss of pitot heat).
  - Autopilot can be re-engaged when flight control normal mode has been restored.
  - Note that this may not happen as pitots are blocked

NOTES:

- Following loss of airspeed indications, use QRH PI Flight with unreliable airspeed.
- **Pitch Attitude approx –1 degree** (this will allow sufficient speed for windmill start)
- When below FL300 and the engines instruments such as N3 and Fuel flow are not showing start attempts, recycle the fuel control switches.
- Give thought to waiting until out of the Ash to Recycle the Fuel Control Switches
- Give thought to only attempting relight on one engine to save the other for lower and maybe out of the ash
- See notes on dual engine failure.
- Note that Engine Instruments will go Red if EGT goes above 700(Start EGT limit). However with autostart the system will control fuel to prevent going above Takeoff EGT
- Give an **"ATTENTION CREW AT STATIONS"** PA if possible.
- Aircraft may depressurise – Oxygen use may be necessary
- APU is more likely to operate as its EGT's are lower than the Engines
- If APU is running, consider a cross bleed start.
- Start selector - start. @Max motoring N3, fuel control switch - run.
- Give a volcanic ash PIREP with Mayday Call.
- Once engines are restarted – treat them carefully (avoid full thrust to climb up again?)
- Note that the **HEAT PITOT LCR** message will go but the **FLIGHT CONTROL MODE** message will still be there as pitots are blocked
- AP will not be avail.
- Some FD Modes will be available
- Groundspeed Available from ND *(TAS increases 2% every 1000 feet)*
- FD's are available in LOC GS modes
- Consider FO to fly approach and Capt to drive thrust based on GS. Take over at 200 ft

ENGINE OIL QUANTITY FCOM Vol 2A -7.20.13

- There are no operating limitations for the engine oil quantity; therefore, there are no flight crew procedures based **solely** on a response to low oil quantity.
- Monitor all the engine parameters particularly oil temperature and oil pressure.
- Monitor further drop in oil quantity.
- Contact Engineering and ask for engine history and advice.
- Consider:
- Routing - ETOPS / Iranian route / suitable airports etc.
- Weather and if day or night.
- Is rerouting an option i.e. via Saudi and possible fuel stop in OERK / OBBI / OTBD.
- What if? What if the oil pressure drops and an engine shutdown is required? Will this be a major worry i.e. a night approach into Iran. If yes - divert. Airport of choice - SMNC Dubai.

ENGINE VIBRATION

- There are no operating limitations for the airborne vibration monitoring system therefore, there are no flight crew procedures based **solely** on a vibration indication.
- Monitor all engine instruments. If tactile vibration is felt then consider accomplishing the ENG LIM/SURGE/STALL L/R recall and checklist.
- The condition being - abnormal engine noises.

PROFILES OF HANDLING ENGINE FAILURES

ENGINE FAILURE ON TAKE-OFF

- PF – "Check power" PNF – Call out failure. Don't specify which engine.

On The Ground

- Look at the runway end. Once yaw is controlled, lock feet (a substantial amount of rudder is required). Rotate **slowly** @ 2°sec^{-1} to **10°**NU. Elevator load is high initially but rapidly lightens. A/C unsticks at 9°, above 10° the speed decays.

- **After Lift-Off**
  - After lift-off, an additional rudder input is required.
  - If engine fails after takeoff, use aileron to keep wings level, then add rudder to keep control wheel level. Down aileron points to the rudder required. Lock feet - don't peddle! (A lot of rudder is required especially with TOGA thrust.)
  - Scan EICAS – command thrust level and red/amber radials on failed engine.
  - Pitch 10°NU.
  - **Keep wings level with aileron - keep bank angles less than 5º if possible. Small, smooth inputs.**
- **Positive Climb** - Gear Up.
- Scan speed and trend arrow versus pitch.
- FD command target speed is **V_2**, existing speed if between **V_2** and **V_2+15**, **V_2+15** if speed is above **V_2+15**.
- If no TAC; apply rudder to centre control column. Down aileron points to the rudder required.
- "Stand on ball and share it with a friend" apply rudder with the live foot until slip indicator is displaced slightly towards the live engine.
- **Only trim when rudder input is correct i.e. the control wheel is centered. Trim towards the live engine (live foot).**
- **Approx 7 – 10 sec of Rudder Trim is required**
  - Rudder trim can be applied at any stage however, do not drive the rudder through the trim. Sort out the rudder input first and then apply rudder trim. Do not get distracted from flying the a/c by looking down at the trim knob.
- When clear of the ground, use aileron to regain required track if regaining track is a requirement.
- Scan ND trackline + A/C ⌐ versus runway extended centre-line

Actions Below 400ft:

- **Gear Up - TOGA thrust if required. (Extra rudder input is required).**
- Performance is not adequate if Speed is below V_2 10ºnu but negative speed trend arrow GPWS - Don't Sink.
- TOGA removes LNAV and VNAV. EOP consideration - Need to reengage a roll mode above 400ft (Re engage LNAV or engage HDG SEL). Use basic modes to accelerate. Advancing the thrust levers to get max rated thrust results in the thrust coming back to D-TO at 400ft when VNAV engages.

400 Feet

- Call for a **lateral mode** to be engaged**.** Straight ahead in TRK SEL or as required by the engine out procedure (EOP). Ask PNF to talk you through the EOP if still hand flying. This is a good time for the PNF to remind the PF that there is an EOP.
- Complete **trimming** the rudder (12 units / 12 seconds) and engage **autopilot.**
- Engage A/P once the rudder is trimmed and when above 200ft.
- PF - PF and PNF need to carefully decide what type of engine failure occurred and if recalls items should be accomplished.
  - Call for **recall items** if required. (Guard and confirm closing of Thrust lever, fuel control s/w, and fire switch.)
- PNF – call out EICAS + failure and cancel master warning or caution when inhibit is removed.
  - Once recall items have been completed, PNF preferably, give a ***PAN/MAYDAY*** call followed by **"*Standby*"**.
  - NB: PF operates MCP, RT, FMC and configuration changes once PNF has been called to do; Recall items or Non-normal checklists.; however, try to manage the situation so that PNF is not performing 1. and 2. above when a configuration change is anticipated. FMC manipulations should be kept to a minimum (eg. Direct to, Hold at, Fix, Navrad, Approach selection but not approach building) until the PNF is back in the loop and monitoring.

E/O Acceleration Height

- 5°NU. Accelerate.
- Retract flaps.
- If not in VNAV, set flaps up speed. Accelerate. Retract flaps.
  - Accelerate at an altitude above the minimum and below the maximum acceleration altitude depending on the circumstance (For example, delay the acceleration if recall items are still being carried out, etc).
- **At $VREF_{30}$ + 80**
- Climb at $VREF_{30}$ + 80 to MSA. Then if required, activate FMC eng-out climb.
- If not in VNAV, select **FLCH** to give a pitch mode and to set CON as the thrust ref.
- If altitude capture occurs first, select CLB/CON for CON thrust reference.
- ***Once aircraft is above MSA,*** "What to do now checklist". (Discuss: weather / fuel / which airport etc)
- Call for PNF to do non-normal checklists and after takeoff checklist.
- Hand over control to PNF, brief Purser (NITS), Give a P.A, set up for next approach. Accomplish approach briefing.
- FMC diversion routing or build another approach. Fuel imbalance: When you turn off the fuel pumps, ensure that the low fuel side is the side with the operating engine.
- If above MLW: Fuel jettison if required or accomplish overweight landing. One engine inop always use flaps 20 for overweight landing.
- Contact EK flight operations/engineering.

ENGINE FAILURE DURING THE CLIMB

- PF - "Check Thrust". PNF to call out the failure.
- Fly the aircraft. If TAC is inoperative, apply rudder and rudder trim to keep the control wheel centered.
- PF call for the recall items if applicable.
- Thrust reference should be CON, if not press MCP CLB/CON.
- FMC: Activate and execute the engine out VNAV page using the ENG OUT prompt.
- PFD selected speed bug should be the engine out climb speed (Best angle climb).
- Altitude capability if the intention is to continue the climb: modify without executing the FMC using the LRC prompt or by manipulating the FMC as necessary to get the respective cruise altitude. Set this altitude on the MCP and push the altitude knob to enter this altitude into the FMC.
- At TOC, execute the LRC profile. The aircraft will accelerate to the LRC speed as fuel burns off.
- If the engine failure occurred above the maximum engine out altitude then a drift down will be required. Set the required engine out altitude on the MCP, execute the modification and press the altitude knob to enter the drift down altitude into the FMC.

ENGINE FAILURE DURING THE CRUISE

- PF: "Check Thrust"
- Fly the A/C. Monitor TAC or apply rudder and then trim (control column - neutral)
  1. Call for or activate the FMC engine out modification (VNAV cruise page)
  2. Set the MCP altitude
  3. Execute the modification
  4. Press MCP ALT to put MCP ALT into FMC CRZ ALT
- Check the PFD for magenta E/O speed. Note speed decay rate.
- Thrust - CON thrust limit - MCT thrust set
- Call for recall items if required. As PF do R/T.
- HDG SEL – Off the airway + parallel. Use of offset or TRK hold.
- Turn on the lights at night.
- Call for applicable checklist.
- Note: Recall may be required before drift down if engine has not failed. If engine fails then consider Driftdown before Recall

BASIC MODES

PF:

- Fly the A/C - Monitor TAC - Apply rudder trim.
- Press MCP CLB/CON for max CON thrust. A/T drives to CON thrust.
- Select Eng Out Page on FMC
- Set E/O altitude
- Set the engine out speed on the MCP.

- Press FLCH
- Disconnect A/T and set Thrust to CON Thrust.
- Press ALT in MCP to get alt set in FMC
- HDG SEL. Parallel airway. A/C decelerates.
- @ E/O DD SPD; engage FLCH
- No FMC:
  - Use turb penetration speeds for D/D
  - Vol 1 Performance: ENG INOP D/D &Level off alt. D/D & LRC altitude and range.

PNF:

- Do recall items if required.
- Mayday call and descent clearance.
- Applicable checklist
- Best altitude performance – E/O drift down followed by E/O cruise. This is the min drag speed profile.
- Best Fuel performance – E/O drift down followed by LRC SPD cruise. Accelerate from the E/O speed to LRC SPD as fuel burns off. LRC SPD is faster than min drag speed
- Best speed performance – CO SPD Drift/Down and cruise. Gives earliest ETA and largest ETOPS footprint. Check FMC max alt with CO SPD modified for CO SPD altitude capability.

ENGINE FAILURE DURING THE APPROACH

- PF - "Check Thrust". PNF to call out the failure.
- Accomplish recall items if applicable and with due consideration of aircraft's position on the approach and the impact of being distracted during an engine shutdown drill.
- If an engine failure occurs on final approach at max landing weight with the flaps in the landing position, there is adequate thrust available to maintain the approach profile using normal landing flaps.
- A landing at F30 might be preferable in some circumstance i.e. short final, short runway, Cat III etc.
- Increase thrust to maintain the appropriate speed.
- The TAC should control the rudder. If not then apply rudder to keep the control wheel centered. (4-6 units rudder trim).
- If the A/P is engaged and below 1500ft (multi-channel engage), the A/P powers the rudder until altitude capture or another pitch/roll mode is selected.
- Use F20 for go-around.
- At weights near the landing climb capability limit, it may be preferable to continue the approach at F20.
- Speed should be increased to 15knots above the previously set F30 Vref.
- This may be accomplished by increasing the MCP speed by 10 Kts and then selecting Flap 20. Pitch changes from 0º to 2½ºnu.
- Use Flap 5 for go-around.
- **ENGINE FIRE**
- If an engine fire occurs after takeoff or during a go - around, engage a lateral mode (ensuring that the FD's are still on) and engage the autopilot before calling for recall items. As PF, you need to be able to monitor the fire engine recall items and trim the a/c whilst the engine is shutdown.
- Also, don't rush in calling for the recall items until the A/P is engaged and clear of high terrain if the engine is still operating.

ENGINE DAMAGE ASSESSMENT

- Damage assessments are usually accomplished:
  - Above 400ft after an engine failure when deciding whether recall items should be called for.
  - Above MSA, when deciding which checklist to call for.
  - Before initiating an engine in-flight start.

What are the Engine Problems we can have on takeoff that may result in a thrust loss or irregularity?

- Engine Fire : Fire Lights and Bell (above 400ft / 25sec).
- Engine Severe Damage: High Limits, thrust Loss and/or Vibration.
- Engine Separation: N1, N2, N3 reads 0.0.
- EPR, EGT, F/F, Oil Temp, Oil Pressure all blank. Oil quantity reads Low.
- A/T disengages (Refer EICAS and FMA).
- EICAS message Fuel Press Eng L/R.
- Engine Failure/Rundown: Thrust Loss and Normal Parameters.
- Engine Surge/Stall or Limit: Above Limit, Vibration, Noise and Thrust Produced.
- N1 Seizure: No Thrust – N1 at 0.
- Thrust Reverser Unlocked: No Thrust. REV briefly amber. FADEC reduces thrust to idle. Thrust lever remains in position but EPR and N1 confirm idle thrust. Green REV on EICAS.

- Check all engine instruments. **(An engine fire can become an engine separation).**
- **Choice of recall actions:**
- **FIRE ENGINE** Recall for - Fire.
- **ENGINE LIMIT/SURGE/STALL** for - engine indications that are abnormal or are approaching or exceeding limits, abnormal engine noises are heard, or there is no response to thrust lever movement.
- **ENGINE SEVERE DAMAGE OR SEPARATION** - for an engine that has severe damage, vibration or has separated.
  - This is a good drill to do if in doubt. Use for thrust reverser unlocked or ask PNF to position the fuel control switch to cut-off.
- For the engine that just flames out / runs down - there are no recall items just an **ENG FAIL** non-normal checklist to be performed at the appropriate time.
- An engine fire can be followed by an engine separation. This may be accompanied by a bang / thud of sorts. The recall actions for the Engine Fire will take care of the actions required for the engine separation case.

INTENTIONALLY BLANK

8. Fire Protection Systems

BOTTLE 1, 2 DISCH ENG

CONDITION:

- Engine fire extinguisher bottle 1 or bottle 2 pressure is low.

REASON:

CHECKLIST:

NOTES:

BOTTLE DISCH APU

CONDITION:

- APU fir extinguisher bottle pressure is low.

REASON:

CHECKLIST:

NOTES:

BOTTLE DISCH CARGO

CONDITION:

- Both rapid discharge cargo fire extinguisher bottle pressures are low.

REASON:

CHECKLIST:

NOTES:

□ DET FIRE APU

CONDITION:

- APU fire detection is inoperative.

REASON:

CHECKLIST:

- If APU not running, do not start APU unless use is required.
- If APU running, plan to shut down APU as soon as practical.

NOTES:

- Only use the APU if absolutely necessary which is unlikely. Consider as if dispatched with APU inop. Perhaps placard the APU to prevent starting it in a rush.

DET FIRE CARGO AFT, FWD

CONDITION:

- Affected compartment smoke detection is inoperative.

REASON:

CHECKLIST:

NOTES:

- Consider what is loaded into that compartment. If there are oxidisers or flammables consider the quantities.
- Seek MEL for guidance.
- Alert the cabin crew to take special notice of the area.
- Remember the cargo fire suppression is still available.

DET FIRE ENG L, R

CONDITION:

- Affected engine fire detection is inoperative.

REASON:

CHECKLIST:

NOTES:

- Engine overheat detection may also be inoperative but this cannot be confirmed unless a manual fire test is done. If this is performed and the **DET OVERHEAT ENG L, R** message remains with the **FIRE TEST FAIL** on EICAS then overheat detection is not available
- If overheat detection is still operative, this can be used as engine fire detection. If an overheat caution is given, this may be a fire

□ FIRE APU ..... Warning Message with Fire Bell

CONDITION:

- Fire is detected in the APU.

REASON:

CHECKLIST:

- Pull and Rotate the APU fire switch. Hold for 1 second.
- Do not accomplish the APU SHUTDOWN checklist.

NOTES:

- A fire signal from either APU fire detector will cause an APU shutdown.
- If the aircraft is on the ground with both engines shutdown, the extinguisher bottle will automatically discharge.

□ FIRE CARGO AFT / FWD ..... Warning Message with Fire Bell

CONDITION:

- Smoke is detected in the aft / fwd cargo compartment.

REASON:

- Smoke NOT Heat is detected.

CHECKLIST:

- Cargo fire arm switches - arms all the extinguishing bottles and the selected compartment valve, turns off both lower recirc fans, shuts down cargo heat, packs go to a minimum flow schedule, bulk cargo ventilation system shutdown (aft only), equipment cooling to override (fwd cargo fire only).
- Cargo fire discharge switch light illuminates when the first of the two extinguisher bottles **begin** to discharge.
- The EICAS advisory message **BOTTLE DISCH CARGO** is displayed when the first two extinguisher bottles have **completely** discharged.
- **Landing altitude selector - pull, set 8000ft**. Minimizes extinguishing agent leakage out of the compartment by reducing the cabin differential and hence the flow of air around the cabin / cargo holds and then out the outflow valves.
- For Fire Cargo **Fwd** - equipment cooling in the normal mode is inoperative. After 30 mins of operation at low altitude and low cabin differential pressure, electronic equipment and displays may fail.
- (Due to the equipment cooling being in override mode and therefore relying on differential pressure for equipment cooling.)
  - Do all preparation at higher altitudes if possible and avoid extended holding and delays at low altitude. If holding becomes a factor consider climbing
  - Monitor the Cabin Diff
  - Turn down cabin temperatures
  - If equipment fails, consider climbing not rushing the approach.
  - As a scenario, how realistic is this because who is to say which equipment fails first?
- ***Plan to land at nearest suitable airport.***
- When at top of descent: *Landing Altitude Selector - Push*.
- [Restores automatic selection of the FMC landing altitude.]

NOTES:

- PF: Stop Climb. Turn towards nearest suitable airport if obvious. Advise PNF of intention
- Ask PNF to accomplish the Fire Cargo Aft / fwd checklist. Advise ATC
- Remember this may only be smoke, or fumes. They may take time to clear or may not clear at all. ***Do not rush***. Prepare for the approach and landing.
- Prepare Cabin for evacuation.
- ETOPS Cargo fire detection, protection and suppression are for 195mins.
- Experience, according to Boeing is that you can smell the cargo smoke prior to the detectors detecting smoke.
- CRM - can cabin crew smell smoke? Any heat?
- Loadsheet - what is in the holds? Dangerous goods? If so advise ATC
- In-flight: two bottles discharged immediately, after a time delay (20mins), the remaining three bottles discharge at a reduced flow rate into the selected compartment. If a/c lands within the 20mins then one of the remaining bottles discharge at the reduced rate on touchdown.
- On landing Evacuate.
- Advise fire services not to open the cargo holds until all are off the aircraft

□ FIRE ENG L, R ..... Warning Message with Fire Bell

CONDITION:

- Fire is detected in the engine.

REASON:

CHECKLIST:

NOTES:

- If an engine fire occurs after takeoff or during a go - around, engage a lateral mode (ensuring that the FD's are still on) and engage the autopilot before calling for recall items. As PF, you need to be able to monitor the fire engine recall items and trim the A/C whilst the engine is shutdown.
- Also, don't rush in calling for the recall items until the A/P is engaged and clear of high terrain if the engine is still operating.

□ FIRE WHEEL WELL ..... Warning Message with Fire Bell

CONDITION:

- Fire is detected in the Main Wheel Well.

REASON:

- This means very high temperatures have been detected in the wheel well.

NOTES:

- PF: Reduce speed to 250 knots. Use speedbrake if appropriate
- Turn towards nearest suitable airport if obvious
- Call for the Fire Wheel Well checklist.
- Plan to land at nearest suitable airport. (Even if fire is extinguished).
- If fire is extinguished, the pressure is off. **Don't rush**
- If fire is extinguished, consider a Fire Test. If the detectors have failed then the message **DET FIRE WHEEL WELL** may remain with the message **FIRE TEST FAIL**. If the detectors have failed, the wheel well may still be on fire
- There may be serious problems on landing. Consider Runway Length, Crosswinds, Fire Services
- Don't use VNAV or FMC performance predictions.
- Landing gear may **only** be retracted if required for **airplane performance** (20 mins after Fire Wheel Well message is no longer displayed). E.g. if doing a Single Engine Go Around
- Consequences of Gear Retraction are: **It may not come down**. The fire may still be smoldering
- Prepare the Crew and Cabin for a possible Gear Failure on landing and Evacuation
- Braking and Stopping may seriously be affected
- **Gear down operations:**
  - Climb @ Vref 30 + 80.
  - At MLW max altitude - FL 220 / FL 230.
  - At MTOW, max altitude - FL 120 / FL 130.
- **Fuel required is approximately double that required gear up**
- Holding (1500ft @ MLW. Flaps up)
- Uses 11 tons per hour. Therefore allow 6 tons for 30 minutes of holding.
- **Short distance Fuel and Time** (VOL 1 PD 23.10). [Assume WC of -40 knots. 220T. Approach allowance of 1000kgs]

- **100nms**: 5.2T + 1.0 + 6T = 12.2T / **12.5 T minimum**. [FL190 / FL 200 Time 0:30 Vref30 + 80]
- **200nms**: 9.6T + 1.0T + 6T = 16.6 / **17.0 T minimum**.[FL 210 / FL 220 Time 0:55 Vref30 + 80]
- **400nms**: 16.6T + 1.0T + 6T = 23.6 / **24.0 T minimum**. [FL 210 / FL 220 Time 1:35 Vref30 + 80]

□ OVERHEAT ENG L, R ..... Caution Message with Beeper

CONDITION:

- Overheat is detected in the nacelle (i.e. this is not an engine overtemp / EGT exceedence).

REASON:

- This is probably a duct leak or an engine case hot air leak. It is detected by the same loops as the fire detection but is not hot enough to trigger the fire warning.

CHECKLIST:

- The Bleed Air Switch is turned off to remove flow of bleed air through the leak (Other engine now at **approach idle).**
- A/T arm switch - OFF.
- The engine is retarded until the **OVERHEAT ENG** message is removed. It is operated at the reduced level for the rest of the flight
  - If **OVERHEAT ENG** message is no longer displayed: operate engine at the reduced thrust level for remainder of flight.
  - If **OVERHEAT ENG** message remains displayed: Shutdown engine by placing fuel control switch to cutout. Land at nearest suitable airport.

NOTES:

- There are 2 detector loops in each engine nacelle. Each detector loop provides both fire and overheat detection. (i.e. same 2 loops for both fire and overheat detection.) Triggered at a lower temperature than a fire.
- Both loops must detect a fire or overheat condition to cause a fire warning or an overheat caution.

μ SMOKE / FUMES / FIREAIR COND - ELEC - REMOVAL

- Cabin smoke or fire has claimed many aircraft. In most cases, the smoke asphyxiates passengers and crew well before fire kills them or the resulting structural damage renders the aircraft uncontrollable.
- In many incidents the time from first warning to crash is less than 10 min.
- **Specific Problems**
  1. Toxic Smoke Inhalation resulting in incapacitation, asphyxiation and death of Crew and Pax.
  2. Lack of Flight Deck Visibility preventing viewing of instruments and outside for landing.
  3. Sooting up of flight instruments thereby preventing their being viewed.
  4. Lack of Cabin Visibility preventing effective source location and fire fighting.
  5. Panics resulting in people migrating around the cabin and into the flight deck.
- **Specific Objectives**
  1. Protect Lungs - Breath Oxygen
  2. Protect Eyes - Goggles are incorporated with the Oxygen Masks
  3. Retain Flight Deck Visibility - Close the Flight-deck Door
  4. Immediately head for the Nearest Suitable Airport
  5. Descend
  6. Increase the airflow through the aircraft
  7. Find and Extinguish the source of the fire as soon as possible
  8. Ensure that you get a complete picture of the situation.
  9. **Land as soon as possible** unless 100 % sure the source is contained and completely extinguished.
- **Possible Complications**
  - There may be multiple indications of Lavatory Smoke as the smoke gets to the detectors.
- **Specific Mistakes**
  - Do not drop the masks - Oxygen from the unused masks may fuel the fire. As the masks do not prevent the Pax from inhaling the cabin air as well, they will not prevent toxic gas inhalation.
  - Do not turn off the bleeds or packs in an attempt to suffocate the fire, as this will ensure that all of the Pax die before the fire does.
- **Considerations**
  - If the situation is very bad, it may be necessary to open the flight deck windows to obtain forward visibility and to clear the flight deck of smoke.
  - Fully open both outflow valves below 12000 ft to increase the airflow and depressurise the aircraft so the side windows can be opened. Ensure Speed less than Vref+80.
  - Source
  - Smoke in the cockpit may come from several sources and the identification of the source is very important in isolating the problem, choosing the correct checklist and dealing with the emergency correctly.
- **Possible Sources:**
  - Air Conditioning Smoke
  - Electrical Smoke
  - Cabin Smoke
  - Volcanic Ash

- **Identification**
  - **1 AIR CONDITIONING SMOKE**
    - ***Dense dark oily smelling smoke*** appearing throughout the aircraft and entering the cockpit through the side walls and around the floor and windshields . **EQUIPMENT COOLING OVERRIDE** may come up if the smoke enters the Equipment Cooling System. Should be smelt before seen
    - If Pack actually burns the sensors should shut it down due overheat
  - **2 ELECTRICAL SMOKE**
    - A concentration of smoke with distinctive "***Burnt Insulation" smell***. Electrical is white/blue. Normally at one panel. If the source is in the flight deck it will not be immediately present in the cabin. In time this may or may not be detected and bring up the **EQUIPMENT COOLING OVERRIDE** on EICAS. Generally a CB has failed to trip and a fire or smouldering has started. Removing the power may not stop the fire if it is established
  - **3 CABIN SMOKE**
    - This will probably first be reported by a cabin crewmember. Cabin fires could be from ovens / hat racks / toilets / seats. It will then come through via the Re-circulation Fans if they are left on or through the flight deck door. Fire could produce white or dark smoke depending on the source of the burning material. It may have any type of smell: Paper - Synthetic - Chemical - Gaseous. Aural Smoke Detectors in the lavatories may alert in one or all areas. A cargo fire or wheel fire may also produce cabin smoke
  - **4 VOLCANIC ASH**
    - Ash cloud may be penetrated by night or by day in IMC. If 8/8 Blue then this is obviously not the problem. This smoke pervades the whole aircraft and all detection systems of smoke may trigger. There are many pointers:
    - Acrid Smell
    - Smoke Entering via the sidewall risers around the floor and windshields
    - St Elmo's Fire at Windshield - Radome - Engine Inlets.
    - Erratic Engine behaviour: High or Fluctuating EGT - Flameout
    - Erratic Airspeed Indications: Generally decreasing
    - EQUIPMENT COOLING OVERRIDE on EICAS
    - FIRE CARGO AFT / FWD
- **Operations**
  - **PF: Don oxygen masks and establish communications** (Note if smoke concentration in the flight deck is small, it may be prudent to delay this as it will seriously impair communications)
  - **HAND OVER CONTROL**
  - **Decide on suitable airport**
  - **Declare an emergency.**
  - **Track towards the nearest suitable or emergency airport.**
  - **Ask Purser where the smoke is coming from and the colour & smell of the smoke.**
    - Air conditioning smoke is black and oily. May be also be Hazy or White
    - Electrical smoke/fumes are white/blue and smells electrical.
    - Cabin fires could be from ovens / hat racks / toilets / seats.
    - A dangerous goods incident could produce fumes in the cabin.
    - A cargo fire or wheel fire may also produce fumes/smoke/smell in the cabin.
  - **Descend at high speed to the grid MORA altitude.**

CABIN FIRE/SMOKE	ELECTRICAL FIRE/SMOKE/FUMES	AIR CONDITIONING SMOKE/FIRE	SUSPECTED DG INCIDENT (fumes in the cabin)	VOLCANIC ASH
Crew Action	**Checklist SMOKE/FUMES/FIRE ELEC**	**Checklist SMOKE/FUMES AIR COND**	Use red Emergency response guide: **Pink section 4.1** Emergency response drills. **Section 3.** Checklist for dangerous goods incident.	**Checklist VOLCANIC ASH**

- Use Autopilot, Autothrottle, Autobrake and Autoland as much as possible.
- If the smoke density is very high in the cabin, do the **SMOKE/FUMES REMOVAL CHECKLIST** first. Then proceed to other checklists e.g. Air conditioning smoke or fumes if this is suspected.
- Good CRM is required to obtain an accurate picture of the situation.
- If a fire extinguisher is to be discharged in the flight deck area, all flight crewmembers must wear oxygen masks and use 100% oxygen with emergency selected. **FCOM Vol 2A 1.45.3**
- Consider:
  - Success of the non-normal ECL.
  - Success of the cabin crews' fire fighting.
  - Intensity and amount of smoke?
  - Is it controllable?

μ SMOKE / FUMES REMOVAL CHECKLIST

Checklist
Put on Masks and establish comms
Close the Flight Deck door
Turn off Gasper, Recirc Fans and Equip Cooling
Evacuate smoke thru Fwd or Aft Outflow Valve by closing the other one
Notes
In essence this is the first step of the **SMOKE/FUMES AIR COND** checklist

- If flight deck visibility is impaired, then the side windows must be opened

FLIGHT WITH COCKPIT WINDOWS OPEN ..... FCOM Vol 2A 1.50.4

A/C must be below 12 000ft. Depressurise the aircraft (Outflow valve switches – Manual and Open both outflow valves). Recommend not to exceed Vref30 + 80.

- When on the ground, with smoke remaining in the cabin, evacuate

PASSENGER EVACUATION.

QRH Checklist Introduction: It should be stressed that for persistent smoke or a fire that cannot be positively confirmed to be completely extinguished, the earliest possible descent, landing, and passenger evacuation should be accomplished

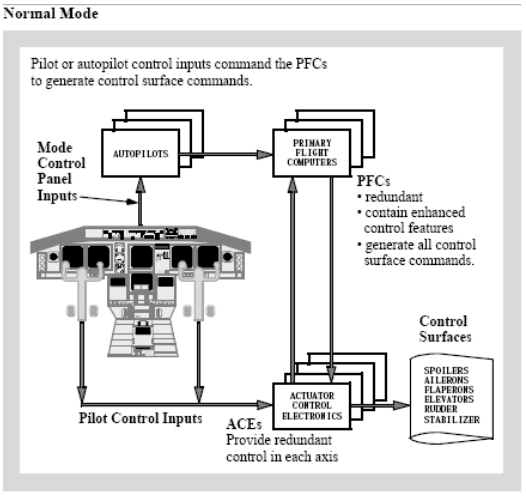
DITCHING

NOTES:

- To load shed utility buses powering Pax entertainment, and galley buses, consider turning off both GCU's. If the electrical fire is started, removing power may not necessarily stop the fire
- **Backup Gens will power essential equipment**
- Turn on both GCU's for approach if absolutely required. Be aware that this may restart a fire

9. Flight Control Systems

- Fight control computers can not override a pilot command.
- Pilot inputs are converted to analog electrical signals; these signals go to 4 ACEs *(Actuator Control Electronics)* that convert analog to digital and digital back to analog. The digital signals are sent to 3 PFCs *(Primary Flight Computers)*.
- The PFCs receive signals from Airspeed, Inertial Data, Angle of attack, and Flap Position. The PFCs are the brains that calculate flight control positions and send them back to the ACEs.
- The ACEs send these signals to the PCUs (Power Control Units) to operate the primary flight controls.

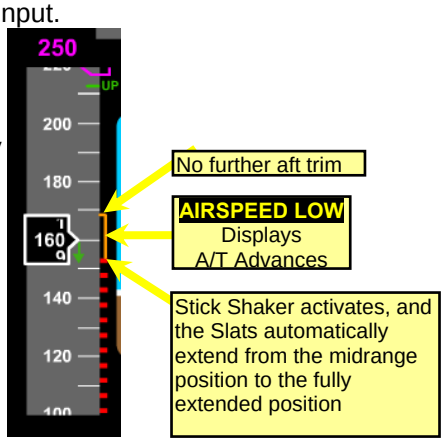


PFCs ENVELOPE PROTECTION FEATURES

- Operate when the autopilot or pilot is flying and can be overridden by pilot input.

Stall Warning

- The lowest speed to which the aircraft can be trimmed is min maneuvering speed, top of the amber band.
- As the airspeed reduces to the ½ of the amber band the EICAS will display "**AIRSPEED LOW**" If the autothrottles are armed they will engage prior to stick shaker to prevent the speed from reaching stick shaker.
  - A/T will not engage when the pitch mode is FLCH or TOGA, or when below 400 feet AGL on take-off, or 100 feet AGL on approach, or during descent in VNAV SPD when the A/T are in HOLD mode.
- Stick shaker, no aural warning.
- Activates at the minimum speed. Top of the red band.

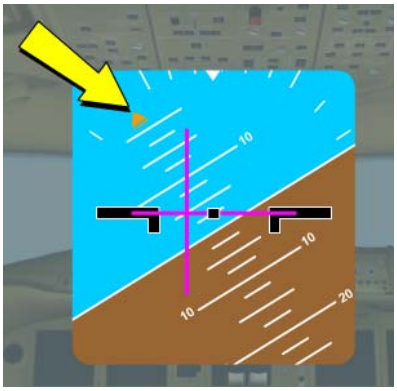


Overspeed Protection

- EICAS warning message and aural alert warn pilot anytime an overspeed condition exists
- Trim is allowed to VMO MMO. Speeds above this will require increased column forces.

Bank Angle Protection

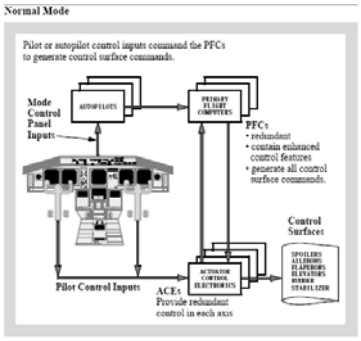
- The Bank pointer changes to amber at bank angles exceeding 35°.
- If the 35° boundary is exceeded the control wheel force rolls the airplane bank to within 30° of bank. This roll command can be overridden by the pilot.
- Bank Angle protection works in both manual and A/P operation; however the A/P disengage bar disables bank angle protection.
- Bank Angle protection is not available in the Secondary and Direct modes.

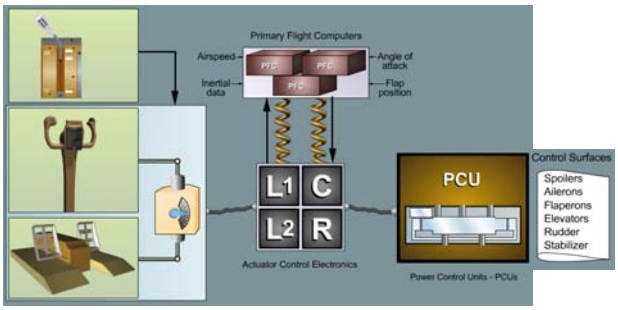


Flight Control Modes of Operation

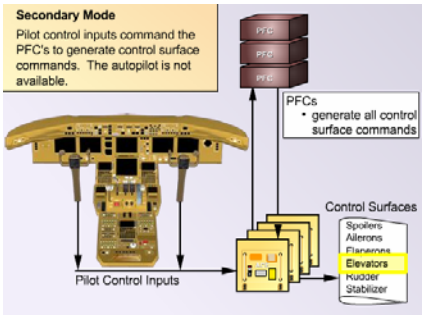
- 3 Modes of operation.

- **NORMAL**
  - Auto-pilots and auto-speedbrakes are only available in normal mode operation.
  - All envelope protection features are available.
  - The PFCs and ACEs are operating.
  - Elevator feel forces are variable based on airspeed.
  - Yaw dampening works.
  - Wheel-to-Rudder crosstie works below 210 knots.
  - Turn Compensation works
  - Auto Speed brakes work.

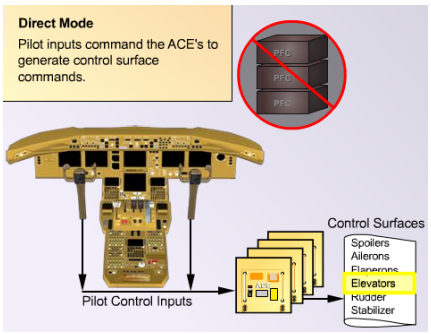




- **SECONDARY**
  - The PFCs automatically switch to secondary mode if the system detects a **loss of airspeed or IRS data**.
  - EICAS message "**FLIGHT CONTROL MODE**" will display
  - The Auto-pilots, Auto Speedbrakes, and Envelope Protection are not available.
  - Gust suppression is inoperative ,Yaw dampening may be lost or degraded, will work if inertial data is available. TAC is inoperative
  - Pilot retains full manual control of the airplane.
  - Elevator feel forces based on two fixed levels. One for flaps down, one for flaps up.
  - Automatic Pitch compensation is not available for, thrust changes, gear config changes, Turbulence, Flap and Speedbrake config changes, turns to 30°.
  - Spoilers 4, 5, 10, 11 are locked out.

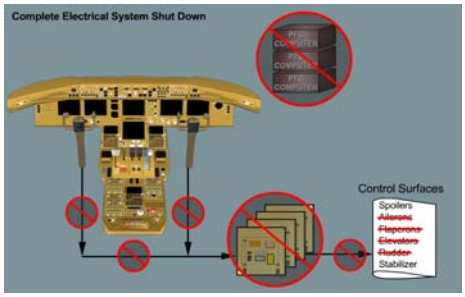


- **DIRECT**
  - The PFCs will automatically switch to direct mode if **other failures occur or the pilot selects disconnect with the PFC disconnect switch**.
  - EICAS message "**PRI FLIGHT COMPUTERS**" will display
  - The ACES disconnect from the PFCs and operated control surfaces directly from pilot inputs.
  - All envelope protection features are removed (Stall / Overspeed / Bank Angle).
  - Gust suppression is inoperative ,Yaw dampening is inoperative. TAC is inoperative
  - Elevator feel forces based on two fixed levels. One for flaps down, one for flaps up.
  - Automatic Pitch compensation is not available for, thrust changes, gear config changes, Turbulence, Flap and Speedbrake config changes, turns to 30°.
  - Spoilers 4, 5, 10, 11 are locked out.



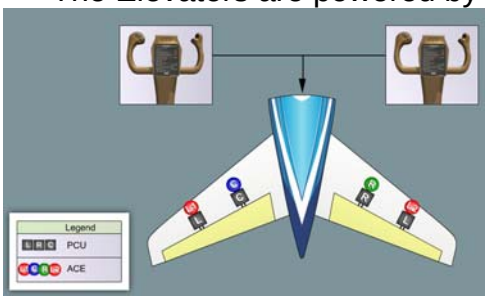
Complete Electrical Failure

- A backup cable system from the flight deck to the stabilizer and selected spoilers allows the pilot to fly straight and level in the unlikely event of a complete electrical system shutdown.

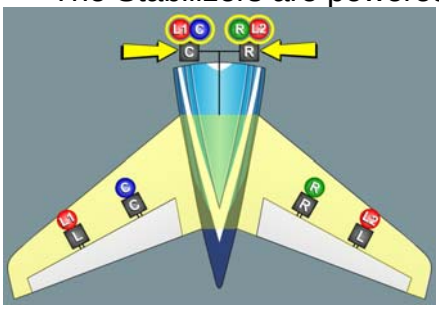


Pitch Control

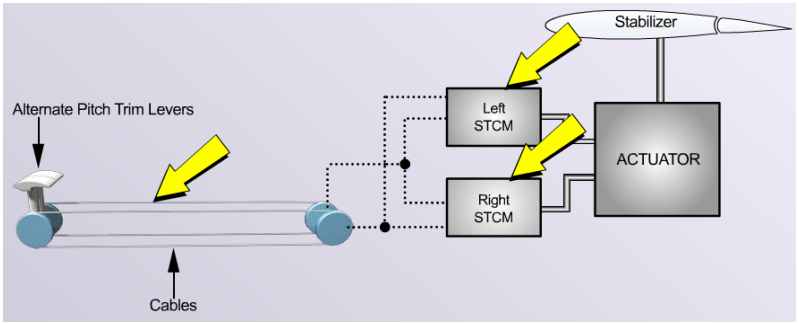
- The Elevators are powered by 3 hydraulic systems and controlled by 4 ACES



- The Stabilizers are powered by the C/R hydraulic systems and controlled by all 4 ACEs.



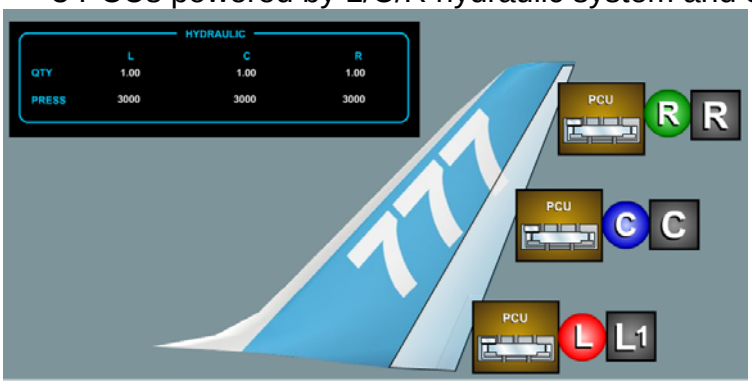
- On ground the green band shows and is computed by the FMC dependent on aircraft weight, C of G, and take-off thrust. The green band is not displayed in flight
- If the green band is not displayed the Stab signal is or is invalid or missing.
- A nose gear oleo pressure switch makes a comparison with the computed Green band and if there is a disagreement a "**STAB GREENBAND**" EICAS message will display.
- When the autopilot is engaged the Pitch trim switches are disabled.
- Pitch trim switches trim for speed changes… 1 sec trim = 10 knots.
- With the autopilot engaged manual trim is only necessary when changing airspeed. Configuration changes do not require manual trim input.
- Alternate Pitch trim switches must be moved together and move the stabilizer directly. Can be cut out with STAB cutout switches.
- If one Stabilizer Trim Control Motor is inoperative the stabilizer will move at a reduced rate.
- Moving the Alternate Pitch trim levers with A/P engaged will move the stabilizer.
- **Note:** Do not move the Alternate Pitch Trim Levers with A/P engaged, or during stall or overspeed protection.



- Alternate Pitch Trim commands have priority over pitch trim commands in all flight control modes.

Rudder Control

- Input via Rudder Pedals, Rudder Trim, Rudder Ratio, and Yaw Dampeners.
- 3 PCUs powered by L/C/R hydraulic system and 3 ACEs.



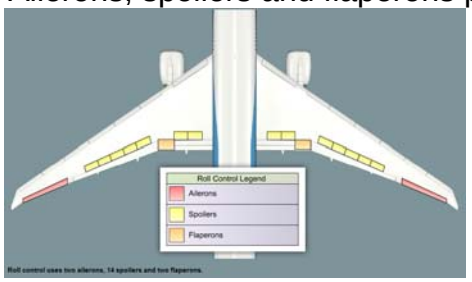
- Yaw dampening is via the PFCs, works in Normal mode, Secondary mode if inertial data is available, and does not work in Direct mode.
- Rudder Ratio adjusts the required rudder deflection based on airspeed. This also provides structural protection.
- Gust suppression adjusts the rudder to provide a smooth ride.
- **TAC Thrust Asymmetry Compensation** assists the pilot after engine failures or when thrust levers are split.
    - TAC is armed above 70 kts and is operation for Manual and Automatic flight.
    - If TAC is automatically or manually disconnected the EICAS message "**THRUST ASYM COMP**" displays.
- **Wheel To Rudder Crosstie** is available in NORMAL mode, below 210 kts control wheel deflection will displace the rudder..

Turn Compensation

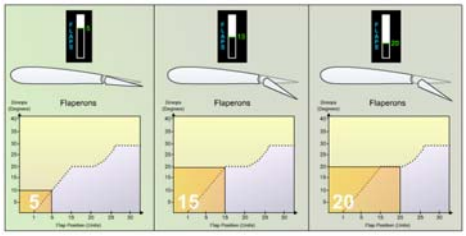
- Eliminates the need for column back pressure up to 30° of bank. Partial compensation is provided up to 60° of bank.

Roll Control

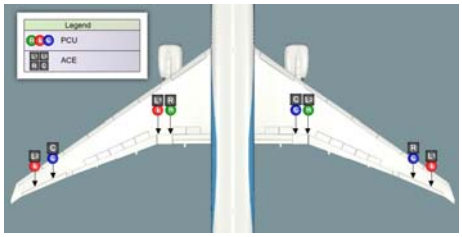
- Ailerons, spoilers and flaperons provide roll control.



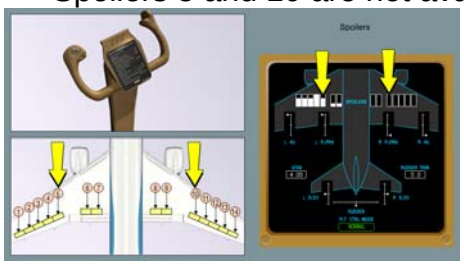
- Ailerons only work at during low speed flight.
- Aileron trim is not possible when the A/P is engaged.
- Flaperons and Ailerons droop at flap settings greater than Flap 1 and operate at low and high speed flight.



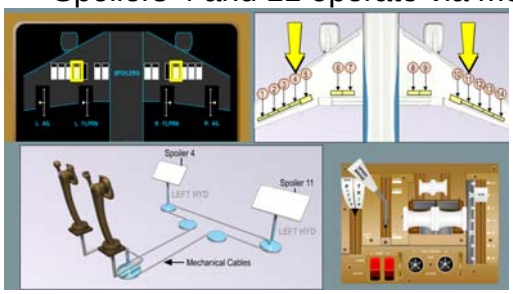
- Two different PCUs power each aileron and flaperon.
- Two different ACEs control each aileron and flaperon.



- Spoilers work asymmetrically and 5 and 10 are only available during slow speed operation.
- Spoilers 5 and 10 are not available in flight as speed brakes.



- Spoilers 4 and 11 operate via mechanical cables for Roll Control and Speed Brakes.



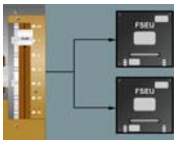
- Bank angle protection is added at 35° the pointer changes color and the control column forces increase.

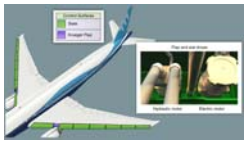
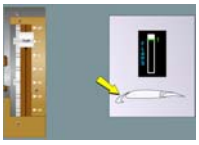
Speedbrake

- **Auto Speedbrake Deployment** (Not available in the SECONDARY or DIRECT modes)
  - **Landing**
    - o If speedbrakes are armed the speedbrakes will move to full up with wheel contact and thrust levers closed.
  - **Rejected Take-off**
    - o If there is a failure to manually extend the speed brakes during a RTO, pulling either reverse lever to the reverse idle detent automatically moves the speedbrake lever to the UP position.
- **Automatic Speedbrake Retraction**
  - **Take-off**
    - o If the speed brake is not in the down detent for takeoff and the takeoff thrust is selected on either engine the speedbrake lever is driven to the down position.

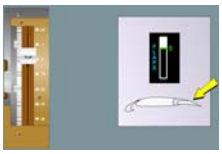
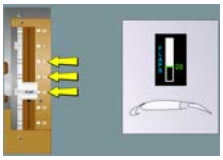
Flap and Slat System

- The PFD displays 2 Flap position maneuvering indications when ever the flaps are not up and the aircraft is below 20,000 feet.
- Flap and Slat extension is inhibited when airspeed is above 275 knots or when above 20,000 feet altitude.
- Selecting Flap 1 sends a signal to 2 FSEU (Flap Slat Electronic Units).
- The FSEU sends a signal to the slat hydraulic motor and the LE slats extend to the mid range position (TE Flaps remain up).

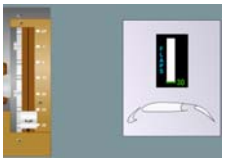


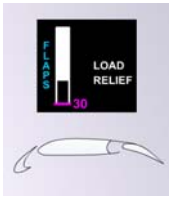
- Moving the Flap handle from UP to 1 extends the Slats to the mid range position, moving the handle between 1 and 20 only extends the TE flaps.
- When Flap 5 is selected IB and OB trailing edge flaps move to the 5 position.
- Flap 5, 15, and 20 are **TAKEOFF FLAP SETTINGS**.

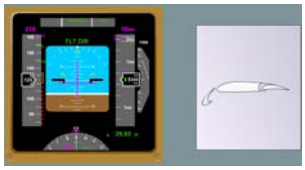
- Selecting Flap 25 or 30 moves the Slats initially moves the slats to the fully extended position then the TE flaps move to the 25 or 30 position.



- In Primary mode **FLAP LOAD RELIEF** operates for flaps 15 to 30. LOAD RELIEF displays on the EICAS flap position display if flap placard speed for one of these positions is Exceeded. The Flap retract to a position adequate for the speed. LOAD RELIEF is limited to flap 5. when airspeed is sufficiently reduced the flaps return to the selected position. LOAD RELIEF will also display if the flap lever is moved out of UP while flaps are inhibited.



- Stall protection is augmented by the **AUTO SLAT SYSTEM**. If the slats are in the midrange position when stall speed is approached they extend automatically to the fully extended position to increase lift. The autoslat system works in the primary mode only.



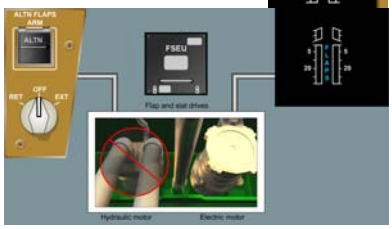
Flap and Slat System 3 Modes of Operation

- **PRIMARY (Hydraulic)**
  - Flaps and Slats use the Center Hydraulic System
  - FSEU *(Flap Slat Electronic Unit)* operate Flap
  - Flap load relief operates.
  - Auto Slat operation for stall protection.
- **SECONDARY (Electric)**
  - EICAS message "**FLAPS PRIMARY FAIL**" displays when the primary mode fails to move the flaps. Secondary mode engages automatically.
  - EICAS message "**SLATS PRIMARY FAIL**" displays when the primary mode fails to move the slats. Secondary mode engages automatically.
  - Once engaged the Secondary mode remains engaged until the affected slats and/or flaps are fully retracted or hydraulic power is restored.
  - Flaps and Slats are electrically powered and move significantly slower.
  - If the Slats are up when secondary mode engages, selecting Flap one will drive the slats to the full down position.

  - If the Slats are in the midrange position when Secondary mode engages the slats will remain partially extended until the flaps are either selected UP or extended beyond 20°.

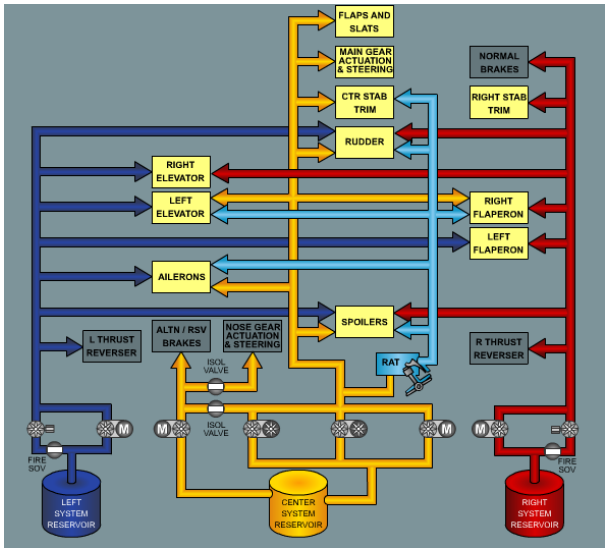
  - Slat Load relief is available.
  - Flaps are positioned electrically at a significantly slower speed.
  - FSEU operate Flap
- **ALTERNATE (Electric)**
  - EICAS Message "**FLAP/SLAT CONTROL**" Primary and Secondary modes have failed and the system must now be selected manually into the Alternate mode.
  - Alternate mode overrides Flap lever inputs.
  - The extend retract signal bypasses the FSEU and goes directly to the flap slat electric motors.

  - The Flap selector must be selected to off when the desired flap position is reached.
  - Max extension is 20° of Flap and Slats to the mid range position.
  - Flap Slat movement must be closely monitored as there is no asymmetry protection. Select the switch to off when the correct position is reached.
  - During Flap/Slat retraction Slat Retraction is inhibited until Flaps are UP.



o

Flight Control Hydraulic Sources



Loss Of One Hydraulic System

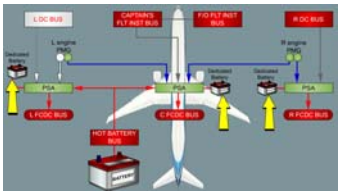
- EICAS Message "□HYD PRESS SYS C". Flaps will operate in the Secondary mod. Checklist will select GPWS FLAP OVERRIDE to OVRD position.
- Roll rate reduced and speedbrake effectiveness reduced in flight and during landing.
- Additional time required for SLAT and FLAP operation.
- To improve G/A performance Flap 20 VREF 20 should be used for landing.
- For G/A do not exceed 256 knots until SLATs retract to midrange.
- To prevent in-flight extension do not arm speedbrake. Manually extend speedbrakes after landing.
- EICAS Mess. "□HYD PRESS SYS L", or "□HYD PRESS SYS R". Roll rate reduced and speedbrake effectiveness reduced in flight and during landing.

Loss Of Two Hydraulic Systems

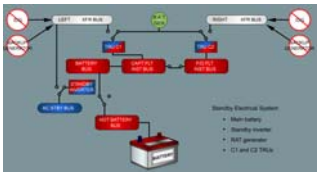
- EICAS Message "□HYD PRESS SYS L+C", "□HYD PRESS SYS L+R", or "□HYD PRESS SYS R+C".
  - Handling qualities degraded.
  - Plan to land at nearest suitable airport.
  - GPWS Flap Overide.
  - Flap 20 and Vref 30+20.
  - Crosswind limit is 20 knots.
  - Roll rate may be reduced in flight. Speedbrake effectiveness may be reduced in flight and during landing.
- EICAS Message "□HYD PRESS SYS L+C".
  - Additional time required for SLAT and FLAP operation.
  - To prevent in-flight extension do not arm speedbrake. Manually extend speedbrakes after landing.
- EICAS Message "□HYD PRESS SYS L+R".
  - Do not exceed .87M. To ensure sufficient roll control.
- EICAS Message "□HYD PRESS SYS R+C".
  - Do not exceed .87M. To ensure sufficient roll control.
  - Both STABILIZER CUTOUT SWITCHES TO CUTOUT (prevents display of STABILIZER message).
  - Do not exceed current airspeed. (Nose down elevator authority is limited).
  - Additional time required for SLAT and FLAP operation.
  - To prevent in-flight extension do not arm speedbrake. Manually extend speedbrakes after landing.
  - Slats will extend beyond midrange when airspeed below 256 knots.
  - For G/A do not exceed 256 knots until SLATs retract to midrange.

Flight Control DC System

- The Flight Control DC electrical system is a dedicated power source for flight control system.
- Primary power for the flight control DC electrical system comes from PMGs (Permanent Magnet Generators) housed within each backup generator.
- Variable frequency PMG AC power is used by individual PSAs (Power Supply Assembly) to provide DC power to the 3 flight control DC busses.



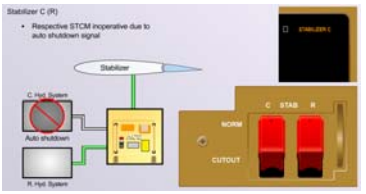
- To ensure a high level of system reliability, each PSA also has multiple DC power sources.
  - The L and R PSA are backed up buy the L and R DC BUS, The C by the CAPT and FO FLT INST BUS
  - The L and C PSA have an additional source of Back up DC power from the Hot Battery Bus
  - Each PSA has an additional dedicated Battery.



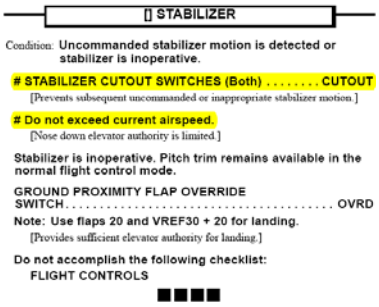
o This power system is also backed up by the Standby Electrical system that provides an additional sources of power to the CAPT FLT INST BUS, FO FLT INST BUS, and the HOT BAT BUS

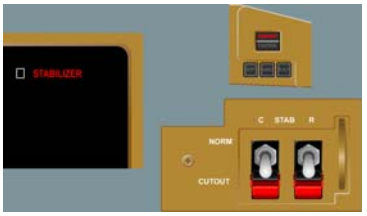
Non-Normals

- If control column or wheel is jammed forcing the other control column or wheel will override the jam.
- If one Stab control module fails the other will operate the Stab at reduced rates.
- If both Stab control modules fail the elevator trim is sufficient to trim the aircraft.
- "□**STABILZER C**" or "□**STABILZER R**" EICAS message displays if the respective STCM (Stabilizer Trim Control Modules) is inoperative due to an auto shutdown signal.
  - Follow respective Checklist.



- "□**STABILZER**" EICAS message displays if both STCMs are automatically shutdown or if there is uncommanded movement of the stabilizer.
  - Complete the required Recall and Checklist





- EICAS message "□**AUTO SEEDBRAKE**". The auto speedbrake feature is inoperative, do not arm the speedbrake. It may be extended manually after landing.
- EICAS message "**SPEEDBRAKE EXTENDED**". Below 800 feet with speed brakes extended, or Landing flaps selected with seedbrakes extended, or Speedbrakes extended with thrust levers not at Idle.
- EICAS message "□**FLAP DRIVE**". A Flap asymmetry condition occurs, the hydraulic and electric drive motors fail, or if uncommanded flap motion is detected. Flap can not be repositioned from this condition. The flap position indicator turns amber

- EICAS message "□**SLATS DRIVE**". A Slat asymmetry condition has occurred, the hydraulic and electric drive motors fail, or if uncommanded slat motion is detected. Slats can not be repositioned from this condition. The Slat position indicator turns amber

- EICAS message "**FLIGHT CONTROLS**". Multiple control surface failures. Pitch and roll response reduced.
- EICAS message "**FLIGHT CONTROL MODE**". Flight controls have degraded to SECONDARY Mode.
- EICAS message "**PRI FLIGHT COMPUTERS**". Flight controls revert to DIRECT Mode.
- EICAS message "**SLATS DRIVE**". A Slat drive motor shut down when a slat asymmetry is detected, the Hydraulic and electric drive motors fail, or there is uncommanded motion. The Slats can not be repositioned from this condition.
- "**CONFIG FLAPS**" EICAS message displays if the Flaps or Slats are not in the Take-off position.

Airplane Differences

200

- Flap/Slat extension inhibited above 20,000 feet and 250 knots.
- Flap Placard Speeds
- No Tail Strike protection is offered by the PFCs in any flight control mode.
- Slats Auto-extend to full extension with an airspeed less than 215. If the airspeed exceeds this speed the slats retract to the midrange position or will not extend beyond the midrange position.
- In the event of hydraulic system failures involving the Center system, on a G/A do not exceed 215 kts until the slats retract to mid range position.

200ER

- Flap/Slat extension inhibited above 20,000 feet and 265 knots.
- Flap Placard Speeds
- No Tail Strike protection is offered by the PFCs in any flight control mode
- Slats Auto-extend to full extension with an airspeed less than 239. If the airspeed exceeds this speed the slats retract to the midrange position or will not extend beyond the midrange position.
- In the event of hydraulic system failures involving the Center system, on a G/A do not exceed 239 kts until the slats retract to mid range position.

200LR

- .
- Flap Placard Speeds
- No Tail Strike protection is offered by the PFCs in any flight control mode

300

- Flap/Slat extension inhibited above 20,000 feet and 265 knots.
- Flap Placard Speeds
- No Tail Strike protection is offered by the PFCs in any flight control mode
- Slats Auto-extend to full extension with an airspeed less than 246. If the airspeed exceeds this speed the slats retract to the midrange position or will not extend beyond the midrange position.
- In the event of hydraulic system failures involving the Center system, on a G/A do not exceed 246 kts until the slats retract to mid range position.

300ER

- Flap Placard Speeds

300ER/ULR

- Flap Placard Speeds

GENERAL TIPS:

- ***Autopilot*** and ***Autoland*** capability
- Weather and ***Crosswind Limitations*** may be a factor
- Weather should be well above minimums.
- For **non-normal configuration**, landing weight must be at or less than MLW. [3200m up to 5000 will cover all cases, including factoring when braking action is good].
- Give yourself plenty of ***time*** to deal with the checklist and configuring the aircraft early.
- When the non-normal checklist is complete except for deferred items, feel free to access the approach checklist to view the deferred items to inform the crew what remains to be accomplished i.e. for planning purposes.
- Do not commence the approach until the non-normal checklist is complete.
- ***APPROACH SPEEDS*** generally higher. Use longest runway. Use generous autobrake settings.

□ FLAPS DRIVE ..... Caution Message with Beeper

GENERAL:

- If flap asymmetry is detected during extension or retraction, the flap drive shuts down and the EICAS message **FLAPS DRIVE** is displayed.
- If uncommanded flap motion is detected, there is an automatic transfer to the secondary mode. The EICAS message **FLAPS PRIMARY FAIL** is displayed. If motion continues, the system shuts down and the EICAS message **FLAPS DRIVE** is displayed.

CONDITION:

CHECKLIST:

- Flap drive mechanism has failed.
- Do not use alternate flaps. [Asymmetry and uncommanded motion not provided].
- Do not use FMC fuel predictions with flaps extended.
- **DISTANCE TO SUITABLE AIRPORT ÷ SPEED** (between current flap maneuvre speed and placard limit speed) **MULTIPLIED BY 60 = TIME**. **FUEL FLOW x TIME = TRIP FUEL REQUIRED.**
- Set the speed and note the fuel flow.
- Add at least 1 tonne on top of this to account for approach allowance plus 30 mins holding.
- Be very conservative.
- Suitable airport choice: weather / approach available / number of runways / terrain etc.
- **Do not fly above FL200.**
- If flap **position** UP or 1: Position **flap lever** to 1 and use Vref30+40 for landing.
- For the remaining flap **positions**, use current flaps.
- Pitch attitude higher than normal on final approach.
- Fly maneuvre speed until on final approach, then reduce to calculated Vref / Vapp + 5.
- Runway length required 2000m. (MLW / MSL - 5000 / flaps 5 or less). [3300m factored by 1.67].
- Don't float.
- Flaps must be at 20 or 30 to accomplish an autoland.

□ FLAPS PRIMARY FAIL ..... Caution Message with Beeper

CONDITION:

- Flaps are operating in secondary mode.

CHECKLIST:

- Plan additional time for slower flap operation
- Use flaps 20 and Vref 20 for landing [Provides improved go-around performance]

NOTES:

- Flaps and slats are driven electrically through the FSEU's. Power source is the L & R Main AC Buses.
- Use the flap lever.
- Do not reduce airspeed too early
- Slats are fully extended at all flap positions. However if they were in the midrange position when the secondary mode engaged, they remain in that position until the flaps are retracted to up or are extended beyond 20.
- This could be the result of the loss of C. Hydraulic system. In this case flaps and slats operate in the secondary mode but the **FLAPS PRIMARY FAIL** checklist is overridden / do not accomplish.
- This could also come from a **BLEED LOSS BODY** as the flaps are slow to extend due no ADP's and switch to secondary mode
- If flaps are retracted, no problem to continue however liaise with engineering and consider destination/company requirements
- **During flap retraction:**
  - Set the maneuver speed for the flaps called for. E.g. Retracting from 5 to 1, set flap 1 maneuver speed.
  - When above MSA, / have advised ATC and situation allows, accomplish the FLAPS PRIMARY FAIL checklist.
  - Retract the flaps using the secondary mode.
  - When flaps have retracted to 1, set flaps up speed retract flaps (Slats). When flaps up engage VNAV or accelerate as required.
- **During flap extension:**
  - Slats go to full extend at the flap 1 position.
  - Flap operation is slow: 0-5 takes 4minutes and 5-20 takes 1minute. Planning is crucial – extend flaps to 20 prior to the FAF/FAP.
  - Use flap 20 for landing. Set Vref 20 for landing.
  - Select the flap, once it has travelled then set the manoeuvre speed.
  - Fly the manoeuvre speed until on final approach and then set the landing speed. (E.g. For flaps 20 landing, set Vref30+20 until on final approach then set Vref 20 for landing).
  - Pitch attitude on a 3ºslope is 2½ºnu.
  - Flaps to remain at F20 for go-around.

□ FLAP/SLAT CONTROL ..... Caution Message with Beeper

CONDITION:

- Flap/slat electronic units are inoperative.

REASONS:

CHECKLIST:

- Directs Alternate Flap/Slat control operation
- Use Flap 20 and Vref 20 for Landing

NOTES:

- During Retraction.
  - Select speed for current flap position as selected.
  - Consider now leaving the flaps here and not retracting as returning may be the best option
  - If asymmetry occurs during the retraction, range, speed, altitudes are very limited
- During Extension
  - Use the alternate flaps selector. Keep hand on the selector and **monitor flap/slat indication**
  - Slats limited to midrange, flaps limited to 20. They **extend simultaneously** but slat retraction is inhibited until the flaps are up. Electric, **slow to extend/retract**, 0-5 takes 4mins. 5-20 takes 1min
  - Select the required flap -wait for it to reach the selected position then set the applicable maneuver speed.
  - **No protection** (asymmetry, flap load relief, autoslat protection, uncommanded motion protection)
  - The alternate slat and flap position indication is displayed automatically when the alternate control mode is armed. Hence it will remain in sight on EICAS even though the slats and flaps are retracted if the alternate control is armed.
  - Suggest extending flaps to 20 prior to the FAF/FAP or in the hold. At FAF/GS capture - gear down.
- **If Flaps/Slats extend asymmetrically** (Torque Tube Failure) then:
  - **AUTOPILOT** disconnect
  - **AUTOTHROTTLE** disconnect
  - **CONFIG WARNING SYS**
  - Autopilot cannot be engaged in a Speed Mode
  - Autothrottle cannot be engaged in a Speed Mode
  - Autopilot may be engaged in a **Path Mode** (V/S, FPA, ALT)
  - TE Flap Indications disappear (PNF must have some idea of where the flaps/slats were at. **Monitor**)
  - For approach speeds refer to the **FLAP DRIVE** checklist. If flaps and slats are up use **Vref30 + 60.** Use min maneuver speed on speed tape which is driven by AoA
  - Flap Markings on ASI Disappear
  - **VNAV Path Deviation Indication Disappears**
  - **If now having to divert:**
    - Do not use FMC fuel predictions with slats/flaps extended.
    - **DISTANCE TO SUITABLE AIRPORT ÷ SPEED** (between current flap manoeuvre speed and placard limit speed) **x 60 = TIME.**
    - **TIME x FUEL FLOW = TRIP FUEL REQUIRED.**
    - Set the speed and note the fuel flow.
    - For holding, flap 1 uses 7% more fuel than flaps up.
    - Add at least 1Tonne on top of this to account for approach allowance plus 30 mins holding.
    - Be very conservative.
    - Suitable airport choice: weather / approach available / number of runways / terrain etc.
    - **Do not fly above FL200**.
    - Do not autoland.
    - This is all due to no valid Flap Position Information

□ FLIGHT CONTROL MODE ..... Caution Message with Beeper

CONDITION:

- Flight control system is operating in secondary mode.

REASONS:

- PFC faults or lack of required information (e.g. airspeed, inertial data) from other a/c systems to the PFC's.

CHECKLIST:

- Attempts to reset the PFC's
- If this is unsuccessful:
- Avoid abrupt control inputs
- Inoperative items are:
  - Autopilot
  - Envelope protection
  - **TAC** and Rudder Crosstie
- Use **Flap 20** and **Vref 20** for landing

NOTES:

- First indication is a **AUTOPILOT DISC** Warning.
- **NO AUTOLAND** due no autopilot
- PFC's only make minimal practical modifications as far as the pilot is concerned. Handling is now conventional i.e. back pressure required during turns, need to adjust pitch for configuration changes and must trim not only for speed changes.
- Primary pitch trim switches and the alternate pitch trim levers move the stab directly (No trim reference speed).
- Considerations due to no autopilot:
  - Duration of Flight
  - Workload
  - Weather / Expected approach (NPA will be difficult)

□ FLIGHT CONTROLS ..... Caution Message with Beeper

CONDITION:

- Multiple flight control surface failures / Multiple flight control surfaces are inoperative due to multiple ACE or multiple hydraulic system failures.
- Other flight control system faults are detected.

CHECKLIST:

- Handling qualities are degraded. [Fewer operating control surfaces]
- Land at **nearest suitable airport.**
- Suitable airport choice: weather / approach available / number of runways / terrain /**crosswind - 20 knots ma**x etc.
- Autoland status?
- Use flaps 20 and **Vref30 + 20** for landing. [Higher approach speeds improve a/c maneuvering characteristics]
- Crosswind limit is **20 knots**.
- Speedbrake may be reduced in flight and during landing.

NOTES:

- Full control is retained but pitch and roll response is reduced i.e. handling qualities are degraded.
- After Checklist is complete review **Synoptic Page**.

□ PITCH DOWN AUTHORITY ..... Caution Message with Beeper

CONDITION:

- Pitch down authority is limited.

CHECKLIST:

- Slower airspeeds assist nose down pitch control. [Airplane is approaching its nose down pitch control limit.]

□ PITCH UP AUTHORITY ..... Caution Message with Beeper

CONDITION:

- Pitch up and flare authority are limited.

CHECKLIST:

- Do not extend flaps any further until on approach. [Airplane is approaching its nose up pitch control limit.]
- **Do not use Autoland.**
- If flap position 15 or less: use **flaps 5** and Vref 30 + 40 for landing.
- If flap position 20 or greater: use **flaps 20** and Vref 30 + 20 for landing.

NOTES:

- Runway length and surface condition is a consideration due to the increased approach speed.

□ PRI FLIGHT COMPUTERS..... Caution Message with Beeper

CONDITION:

- Flight control system is operating in **DIRECT MODE**.

REASONS:

- ACE's detect the failure of all 3 PFC's or have lost communication with the PFC's

CHECKLIST:

- **PRIMARY FLIGHT COMPUTERS - DISC THEN AUTO**
- Inoperative items are:
  - **Autopilot** / Envelope protection / TAC / yaw damping / rudder manual trim cancel switch.
- Use **flaps 20** and **Vref 20** for landing.

NOTES:

- First indication is possibly an **AUTOPILOT DISC** Warning.
- **NO AUTOLAND** due no autopilot
- The control inputs to the ACE's are sent directly to the flight control PCU's bypassing the PFC's.
- Handling is now conventional i.e. back pressure required during turns, need to adjust pitch for configuration changes and must trim not only for speed changes.
- Primary pitch trim switches and the alternate pitch trim levers move the stab directly (No trim reference speed).
- With yaw damping inoperative avoid flying unnecessarily high or fast.
- Considerations due to no autopilot:
  - Duration of Flight
  - Workload
  - Weather / Expected approach (NPA will be difficult)

□ SLATS DRIVE..... Caution Message with Beeper

GENERAL:

- If slat asymmetry is detected during extension or retraction, or the loss of all but the most outboard slats is detected, the slat drive shuts down and the EICAS message **SLATS DRIVE** is displayed.
- If uncommanded slat motion is detected, there is an automatic transfer to the secondary mode. The EICAS message **SLATS PRIMARY FAIL** is displayed. If motion continues, the system shuts down and the EICAS message **SLATS DRIVE** is displayed.

CONDITION:

- Slat drive mechanism has failed.

CHECKLIST:

- **Do not use alternate flaps**. [Asymmetry and uncommanded motion not provided].
- Do not use FMC fuel predictions with slats extended.
  - **DISTANCE TO SUITABLE AIRPORT ÷ SPEED** (between current flap manoeuvre speed and placard limit speed) **x 60 = TIME.**
  - **TIME x FUEL FLOW = TRIP FUEL REQUIRED.**
- Set the speed and note the fuel flow.
- For holding, flap 1 uses 7% more fuel than flaps up.
- Add at least 1 tonne on top of this to account for approach allowance plus 30 mins holding.
- Be very conservative.
- Suitable airport choice: weather / approach available / number of runways / terrain etc.
- **Do not fly above FL200**.
- Do not autoland.
- Use flaps 20 and Vref30 +30 for landing. [provides better handling qualities when slats not fully extended]
- Slats shutdown but flaps operate normally via hydraulics. Use the Flap lever.
- The QRH / ECL procedure will accommodate the most extreme malfunction; i.e. no leading edge slats extended on one wing.

□ SLATS PRIMARY FAIL ..... Caution Message with Beeper

CONDITION:

- Slats are operating in secondary mode.

CHECKLIST:

- Plan additional time for slower flap operation

NOTES:

- Flaps and slats are driven electrically through the FSEU's. Power source is the L & R Main AC Buses.
- Use the flap lever.
- Do not reduce airspeed too early
- Slats go to full extend when flap 1 is selected. However if they were in the midrange position when the secondary mode engaged, they remain in that position until the flaps are retracted to up or are extended beyond 20.
- This could be the result of the loss of C. Hydraulic system. In this case flaps and slats operate in the secondary mode but the **SLATS PRIMARY FAIL** checklist is overridden / do not accomplish.
- This could also come from a **BLEED LOSS BODY** as the flaps are slow to extend due no ADP's and switch to secondary mode
- **LOSS OF FLAP / SLAT INDICATIONS**
- Use the EICAS to determine whether or not a non-normal condition occurs.
- PFD speed tape manoeuvre margins are angle of attack based and will give an indication that the current speed is not appropriate for the current configuration.

□ STAB GREENBAND..... Caution Message with Beeper

CONDITION:

- Nose gear pressure switch disagrees with computed stabiliser greenband.

CHECKLIST:

- FMC weight and CG entries - check

REASON:

- The greenband is calculated using the FMC inputs of CG, gross weight and takeoff thrust.
- A nose gear oleo pressure switch provides an automatic crosscheck of the CG to ensure that the **correct greenband has been selected.** When either the nose up or nose down band is selected, the pressure switch position is compared to the computed greenband.

NOTES:

- **Independently both pilots check the loadsheet especially the DOW & DOI within acceptable ranges.**
- Red cap to get positions of containers visually checked and to crosscheck paper with reference weight and balance.
- Enter into FMC an acceptable T/O MAC as close to the loadsheet one as possible, which does not cause the STAB GREENBAND to be displayed.
- Ask load control to redistribute the payload (cargo / Pax) so as to achieve this T/O MAC.
- This scenario has occurred when operating at very light weights.

□ STABILIZER ..... Warning Message with Siren

CONDITION:

- Uncommanded stabilizer motion is detected or stabilizer is inoperative.

REASON:

- The EICAS warning message **STABILIZER** is displayed if both stabilizer modules have automatically shutdown to stop uncommanded motion.

CHECKLIST:

- STABILIZER Recall items:
  - Stab cutout switches (both) - cutout.
  - Do not exceed current airspeed. (Due to limited nose down elevator authority).
- Recall items performed by PNF as per other recall items.
  - Stabilizer is inoperative. Pitch Trim remains available in the Normal Flight Control Mode
- Use Flaps 20 and **Vref 30+20** for landing

NOTES:

- The R and C hydraulic systems power the stabilizer.
- Stabilizer warning is replaced with the advisory message **STABILIZER CUTOUT** when both cutout switches are in cutout.
- In the Normal flight control mode when the stabilizer is manually shutdown or failed, pitch trim is still available. The PFC's reposition the elevators to trim the aircraft i.e. to change the trim reference speed. However the stabilizer is not streamlined with the elevator.

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10. Flight Instruments and Displays

Inboard Displays

- Two selectors control inboard displays.
- MFD is the normal selection. With MFD selected the ND is displayed on the inboard display.
- PFD will display the PFD on the Inboard Display and inhibit the display select panel for the corresponding inboard display.
- NAV will display the NAV on the Inboard Display and inhibit the display select panel for the corresponding inboard display.
- EICAS will display the EICAS on the Inboard Display and will only allow ENG, FUEL, and AIR functions on the Display Select Panel to be used.
- In the event of an upper center display unit failure, the EICAS switches automatically to the lower center display unit.
    - In this situation selecting EICAS to an inboard display unit now moves the EICAS display there. The secondary instruments will appear on the lower center display unit provided no latched condition exists.
    - The lower center display retains the normal MFD capability after this automatic reconfigure.

- In the event of an outboard display unit failure, the PFD will automatically appear on the inboard display unit regardless of the inboard display selector position.
- In the display system will automatically reconfigure when a source fault is detected.
- If the system does not automatically reconfigure the Display Control Source switches allow the crew to manually select an alternate source.
    - The DSPL CTRL switch selects an alternate display channel.
    - The NAV and AIR DATA/ATT switches manually select an alternate information source for the PFD and ND.

□ ALTN ATTITUDE

CONDITION:
- Both AIR DATA / ATTITUDE source switches are in th ALTN position

CHECKLIST:
- Note: Both PFD's and the Standby Attitude Indicator are displaying SAARU attitude information

NOTES:
- This should not normally occur

BARO SET DISAGREE

CONDITION:
- Captains and First Officer's Barometric settings disagree

NOTES:

DISPLAY SELECT PNL

CONDITION:
- Left, Center or Right CDU control of the DSP is active

REASON:

NOTES:
- CDU control of the DSP control panel is accessed from the CDU menu page

□ EFIS CONTROL PANEL L, R

CONDITION:
- EFIS control Panel is inoperative or CDU control of the EFIS control panel is active

REASON:

CHECKLIST:
- Note: CDU control of the EFIS control panel is accessed from the CDU menu page

NOTES:
- To enter Standard Altimeter setting, type in "S" or "STD"
- If changing the Nav Switching to ADF or VOR, be aware that both change with the selection

SGL SOURCE AIR DATA

CONDITION:
- Both PFD's are receiving air data from the same single channel source

REASON:

NOTES:
- Any single source message will prohibit Autoland
- There may be a **NO AUTOLAND** message

□ SGL SOURCE DISPLAYS ..... Caution Message with Beeper

CONDITION:
- A single source of display information is being used by some or all display units

REASON:
- Graphics Generator failures have occurred

CHECKLIST:
- Note: Both PFD's and ND's or just both ND's are displaying information generated from a single source. Lower center display unit may be blank or may not be capable of displaying all normal formats. Left EFIS Control Panel controls either right PFD and ND or right ND only

NOTES:
- Any single source message will prohibit Autoland
- There will **not** be a **NO AUTOLAND** message as the autopilot is capable of Autoland but individual monitoring is not possible

SGL SOURCE RAD ALT

CONDITION:

- Both PFD's are using the same source for radio altimeter information

REASON:

NOTES:

- Any single source message will prohibit Autoland
- There may be a **NO AUTOLAND** message

SINGLE SOURCE F/D

CONDITION:

- Both PFD's are using the same source for flight director information.

REASON:

NOTES:

- Any single source message will prohibit Autoland

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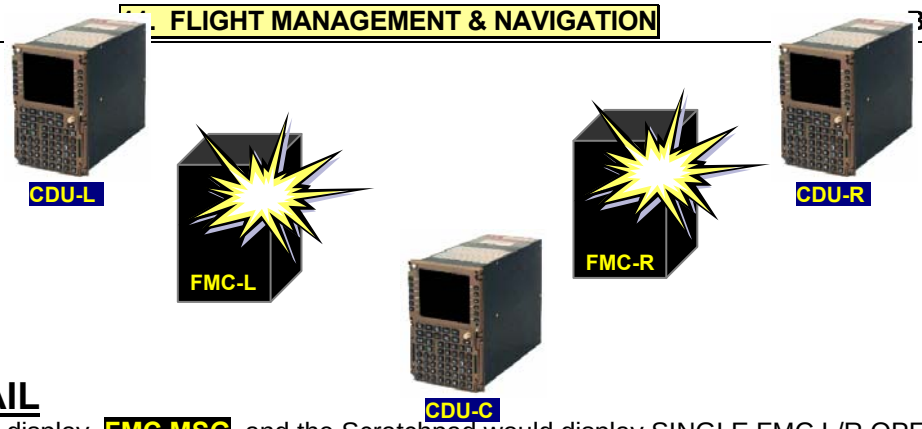
11. Flight Management & Navigation

- Heading Data comes from the ADIRU.
- Air Data comes from the ADIRU or SAARU.
- 4 Primary Display Modes are available
    - **APPROACH MODE**
        - Can display in expanded compass rose or in a centered format with full compass rose
        - Heading Up Display.
        - ILS Data is displayed in the upper right corner.
            - Priority for the displays are for the Captain **L→R** and for the FO **R→L**
        - LOC and G/S Deviation indicators fill when the deviation is slightly more than 2 dots.
        - An expanded LOC display shows on the PFD but not on the ND.
        - Excessive deviations will display after LOC and G/S captured and below 500'RA.
        - Range information is displayed in expanded mode when TCAS or Wx radar is displayed
    - **VOR MODE**
        - Can display in expanded compass rose or in a centered format with full compass rose
        - Heading Up Display.
        - VOR Data is displayed in the upper right corner.
            - Priority for the displays are for the Captain **L→C→R** and for the FO **R→C→L**
        - **VOR** Pointer information is **GREEN**, **ADF** pointers are **BLUE**
        - Left pointers are a single line, right pointers are a double line.
        - Range information is displayed in expanded mode when TCAS or Wx radar is displayed
    - **MAP MODE**
        - Recommended mode for most phases of flight
        - Can display in expanded compass rose or in a centered format with full compass rose.
        - Selected heading / track line only displayed for **10 seconds**.
        - Heading Up Display.
    - **PLAN MODE**
        - Displays non-moving map information in a centered display always oriented to true north.
        - Alternate Airports are displayed at all times. Up to 4 may be on the display depending on the range selected. *(They correspond to the airports on the Alternate airport page)*
- Heading Reference Control.
        - In Normal switching between Magnetic and True occurs automatically above 82° latitude or in the vicinity on the magnetic poles.
        - When the PFD and ND are referenced to True North:
            - If the aircraft descend 2,000 feet at more than 800 fpm the attention box turns to amber and starts flashing. The box returns to white when the aircraft climbs 2,000 feet at more than 500 fpm.

- FMC Failures:



SINGLE FMC FAIL

- The EICAS would display **FMC MSG**, and the Scratchpad would display SINGLE FMC L/R OPERATION..
- Crew action is not necessary
- A software reset may occur, the active route becomes inactive and PERF INIT data is lost. Activate and execute the Flight Plan and re-enter the PERF INIT data.
- If TIMEOUT RESELECT displays in the scratchpad when the FMC is no longer connected to the CDU. Select the <FMC prompt to connect the CDU to the FMC

BOTH FMCS FAIL

- EICAS would display **□FMC**.
- Alternate Navigation occurs automatically 2 seconds after the last FMC fails.
- Alternate Lateral Guidance is not enabled for an additional 3 seconds after Alternate Navigation initializes. VNAV is not available. Reselect LNAV to engage LNAV.
- The CDUs supply route data to the NDs.
- One CDU supplies LNAV guidance to the Auto-Pilot. The ADIRU provides position data for navigation.
- Three CDU pages are available.

o ALTN NAV LEGS

- The CDUs retain the flight plan waypoints except for conditional waypoints, offsets, and holding patterns. **DISCON** will display if there were conditional waypoints on the original LEGS page
- VNAV information is not displayed and is not available.
- Modifications made on one CDU do not display on the other CDUs. On execution data is transferred to all CDUs.
- Only two types of fix entries are allowed.
  - Fix identifiers that are already in the flight plan.
  - Lat/Long waypoints.
- Track information is Magnetic to first waypoint and True to all subsequent waypoints.

o ALTN NAV PROGRESS

- First Line is the From Waypoint and crossing altitude.
- Next line is the Next waypoint DTG and TTG
- Dest line is the same and can be changed to provide additional information.
- Line 5 gives current LAT / LONG and G/S
- Line 6 XTC, DTK desired track, TK current track.

o ALTN NAV RADIO

- Radios must be tuned manually from the L and R CDU ALT NAV RADIO pages.
  - Left CDU controls the L and C ILS, L VOR, and the L ADF.
  - Right CDU controls the R ILS, R VOR, and the R ADF.
- All entries must be frequencies, Identifiers will not be accepted.
- Valid entries are **FREQ**, or **FREQ / COURSE**.
- If ILS FREQ / COURSE entries are different on the L and R CDUs they will display amber and stroked out… Both frequencies must be changed at the same time.
- ILS DME displays only on the ND when APP MODE is selected

NAVIGATION DISPLAY NON-NORMALS

- The **NAV ADIRU INERTIAL** caution message Indicates ADIRU inertial navigation failure.
    - GPS track and position data is automatically selected if not already being used.
    - LNAV and VNAV guidance are not available; however, HDG HOLD and HDG SEL may still be used to follow the FMC flight plan.
- The **FMC L** and **FMC R** advisory messages are displayed when both FMCs have failed.
    - A CDU is automatically selected to control the CDU stored map data sent to each ND. Pressing the NAV sws is not required.
    - Normally the Left CDU generates the Left ND map and the Right CDU the right ND map. The Center CDU is automatically selected as a backup if the left or right CDU fails.
    - The NAV switch only allows CDU Map viewing it does not transfer control of the FMC functions to the CDU.
    - All radio tuning must be done manually through the onside CDU.
    - The NAV RAD page only displays frequency for its side. All entries must be frequencies, no Identifiers are accepted. If ILS Freq course entries are different on Left and Right sides they will display amber and stroked out, both frequencies must be changed at same time.

RADIO TUNING

- Radios are tuned with the NAV RADIO page
  - The NAV display shows the frequency first then when identified displays the IDENT.
  - VORs can be tuned three ways
    - **A** Automatic Tuning.
    - **R** tuned because it is part of the active route.
    - **P** tuned because it is a required part of the approach or departure procedure.
    - **M** tuned manually.
      - VOR entries can be Frequency or Identifier, Frequency / Course, or Identifier / Course.
  - ADF can only be tuned manually
    - **408.0** indicates ADF mode.
    - **408.0 ANT** .indicates Antenna mode. Enter an **A** to enter this mode.
    - **408.0 BFO** .indicates BFO mode. Enter a **B** to get into this mode.
- **SINGLE SOURCE ILS** caution message displays if 2 of 3 ILS receivers fail.

FMC FUNCTIONS Error! Bookmark not defined.

- **RTA**
  - This feature is accessed on **PROG** page 3.
  - Entries can be time or time+condition.
  - **1510** to arrive at this time.
  - **1510A** to arrive at or after this time.
  - **1510B** to arrive at or before this time.
- **REF NAV DATA**
  - This feature is accessed on **INDEX** page.
  - Can be used to get Waypoint Lat. Long.
  - Can be used to get Inhibit NAVAIDs
  - Can be used to get Inhibit VORs
- **POSITION REF**
  - Manual updating is accomplished on **POS REF** page 2.
    - Select **ARM**
    - Select desired update **INERTIAL / GPS / RADIO**.
- **STEP CLIMB**
  - Step Climbs are entered on the LEGS page.
    - Enter the altitude with an S for the step climb waypoint **390S**.

- o

- **RTE LEGS**
  - Direct to a Waypoint:
    - Enter the desired waypoint on line 1 of Legs page 1.
  - Intercept course inbound to:
    - Enter the desired waypoint on line 1 of Legs page 1 then select the desired intercept course to in R5.
  - Course from present position:
    - P/P followed by the desired course eg. **P/P150**.
    - To intercept an active route select the next desired waypoint into the DISCON.
  - Course outbound from a waypoint
    - Type the Waypoint name followed by the desired course into the active waypoint. Eg. **OED169** the outbound course can be changed at R5 until it is executed.
    - Heading select or track select will have to be used to intercept this course.
- **OFFSETs**
  - Accessed on the ROUTE page 2:
    - Offsets may be entered up to 99 nm eg **L99**.
- **LAT LONG REPORTING**
  - Enter the desired LAT or LONG in L1 of Legs page 1 eg. **W144** or **S10**.
  - To report ever 4 degrees enter **W144-4** or **S10-5**.
- **FIX PAGE**
  - 4 pages are available.
  - Can be used to calculate:
    - Where a distance from the fix intercepts the course.
    - Where a radial from the fix intercepts the course.
    - The Abeam point.
  - Can be used to display:
    - At what point a FL will be crossed **FL190**.
    - At what point an ETA will met **1630Z**
- **OFFPATH DESCENT**
  - This page is available from the VNAV DESCENT page.
- **ALTERNATE PAGE**
  - This page can be displayed 4 ways.
    - From the ALT key.
    - RTE page 1.
    - FMC COMM page.
    - INDEX page
  - The FMC selects 4 potential airports from the navigation database.
    - The FMC ignores runways shorter than the company specified minimums.
    - Up to 2 airports can be inhibited from being used by the FMC.
  - The procedure for diverting to an alternate airport is:.
    - Co-ordinate Diversion Airport with Dispatch.
    - Select or input desired airport on ALT page 1.
    - Select DIRECT, OFFSET, or OVER from the ALTERNATE AIRPORT page.
    - Select DIVERT NOW.
    - EXECUTE

- **VNAV CRUISE PAGE**
  - **CRUISE SPEEDS**
    - **ECON** which is a balance of Fuel and time savings as determined by the Cost Index. At High CI this speed may be limited by the **VNAV SPEED LIMIT** (Vmo-5kts) or **CRUISE THRUST LIMIT** (Cruise speed at max cruise thrust).
    - **LRC** which is 99% of MRC and is approximated by a **CI 140** or approximately a cruise of **M.84**.
    - **ENG OUT**.
      - To be legal to dispatch the airplanes **net engine inop. performance** (actual drift down profile reduced by 1.1% gradient capability) must be capable of clearing all the enroute terrain within 5 sm of the intended route by 2,000 feet during an engine inop. Drift down and 1,000 feet after the net engine inop. level off height has been reached.
      - If terrain clearance is not a consideration the pilot may choose to fly engine out LRC or a company defined speed. Max Altitude will be based on the current active speed… EO SPD, LRC, or CO SPD.
      - If the FMC is inoperative the pilot can obtain the same data from the QRH Performance-In-flight section.
  - **CRUISE ALTITUDES**
    - **MAX** based on the more limiting of the **Thrust Limited Altitude** (minimum residual rate of climb of 100 fpm) This is roughly 2,000 feet above OPT altitude up to a temperature of ISA+15°C. Or the **Maneuver Margin Limited Altitude** (based on the JAR/CAA limit of .3G this is the same as a 39°bank turn). It is a function **WEIGHT**, and **TEMP**.
    - **OPT** most economic altitude for total trip costs. It is a function **WEIGHT**, **TEMP**, and **COST INDEX**.
    - **RECMD** this is the most economical altitude to fly for the next 500 nm. It is a function **WEIGHT**, **TEMP**, **COST INDEX**, and **WIND**. The FMC evaluates winds from 9,000 feet below current cruise altitude to just below maximum altitude. Recommended altitude is selected consistent with the step climb schedule and specified step size. Recommended cruise altitude is set to the current cruise altitude when within 500nm of descent.

FMC

CONDITION:

- Both FMC's have failed or FMC selector is in L with the left FMC failed or in R with right FMC failed

REASON:

- This can occur on some approaches due to corrupted database information

CHECKLIST:

- Select appropriate AP modes
- LNAV can be re-engaged but new waypoints must be entered by LAT/LONG
- Manually tune Radios on each side thru the Altn NavRad page
- Use P.I. for Vref and other performance data
- Set Landing Altitude Manually

NOTES:

- If in LNAV or VNAV, **AUTOPILOT** message will appear (A/P is operating in a degraded mode. Engaged pitch /roll mode have failed).
- FMA: Amber lines drawn through LNAV and VNAV. (FMC input to A/P invalid).
- The Master CDU uses **ADIRU position data** for navigation.
- **FMC** (Both FMC's have failed)
- Use the A/P.
- Use basic AFDS modes (TOGA or TRK SEL/HOLD and FLCH). LNAV can be re-engaged - check active waypoint and track first.
- A/T may be available.
- Establish appropriate AFDS modes and CDU / Nav radio navigation and situation awareness before doing the FMC Non-Normal ECL.
- Read the FMC non-normal checklist.
- Report to ATC that Navigation has been degraded as per **FOM 10.pg9**

NAVIGATION:

- MAP mode is available. Use TRK SEL then LNAV to fly the required track.
- CDU navigation:
- CDU legs page maintains most of the waypoints after the FMC failure.
- Conditional waypoints are lost and replaced by route discontinuities.
- Use **Lat & Long** for any additional waypoints. (Remember that CDU does not have a database from which to recognize names.
- **Direct To function is available**.
- Intercept course TO / FROM functions / PBD / PB-PB functions are all inoperative.
- Raw data on the VOR / APP mode using NAVRAD pre-selected frequencies and courses. Note: Use L CDU to tune L and C ILS and R CDU to tune R ILS.
- ALTN PROGRESS page has useful information including:
- GS / XTK error L or R of course / DTK - desired track to next waypoint / TK - actual track.
- Approach:
- ILS - Cannot select an approach through DEP/ARR page. Manually tune ILS on NavRad. FD's available. Use ND - APP mode.
- NPA - Cannot select an approach through DEP/ARR page. Manually tune NavAids on NavRad. FD's available. Use ND - VOR / CTR VOR mode.

OTHER

- The CDU's automatically supply route data to the ND's and one of the CDU's supplies LNAV guidance to the A/P.
- The CDU's calculate lateral navigation for the AFDS using ADIRU position data.
- The A/P selects a master CDU for lateral steering commands in this order: left if functioning, then the centre and then right.
- During alternate navigation the CDU's use their own memory and computing capability.
- The ADIRU supplies magnetic variation at present position so only the active waypoint course can be referenced to magnetic north.
- The CDU's do not have a performance or navigation database.
- Use QRH in-flight performance.
- Set the landing altitude manually.
- Preflight - when setting up for the departure, use the FMC NavRad pre-select feature to facilitate the reversion to raw data operation.
- If a dual FMC failure occurs; engage the A/P, use basic AFDS modes initially at least until legs page is verified suitable for LNAV.

CDU message FMC

CONDITION:

- Affected FMC has failed

NOTES:

- Be prepared for the implications of a dual FMC failure if the other FMC should fail.
- Bug current Vref
- Enter an approach early
- Preselect any useful Nav Aids

FMC MESSAGE

CONDITION:

- A message is in the FMC scratchpad

NOTES:

GPS

CONDITION:

- GPS has failed

REASON:

CHECKLIST:

NOTES:

- Be alert for possible map shift.
- Report to ATC that Navigation has been degraded as per **FOM 19.6.5.2**

□ ILS ANTENNA ..... Caution Message with Beeper

CONDITION:

- Two or more ILS receivers are not using the correct antennas for best reception

REASON:

CHECKLIST:

- Note: AFDS may have difficulty capturing and/or tracking localiser and/or glideslope. Airplane path may be lower than indicated by glideslope pointer

NOTES:

- This would prohibit the use of ILS or LOC approaches
- Ensure that intended airfield has NPA approach available and weather is well above the required minima

□ NAV ADIRU INERTIAL ..... Caution Message with Beeper

CONDITION:

- The ADIRU is not capable of providing valid attitude, position, heading, track & groundspeed.

REASON:

- There is a total ADIRU failure or the inertial reference part of the ADIRU has failed

CHECKLIST:

NOTES:

- With the AIR DATA/ATT s/w in the normal position, the ADIRU provides attitude information to the PFD and ND. The SAARU is the alternate source of attitude information. If the ADIRU fails, SAARU automatically supplies attitude, heading and air data.
- SAARU provides attitude, heading, and air data. SAARU heading must be manually set to the magnetic heading (standby compass) periodically via the SET HDG line on the FMC POS INIT page 1/3.
- The GPS provides Track and Position Data
- **Inop items include**: LNAV, VNAV, TOGA, LOC, GS, TRK HOLD/ SEL AFDS modes. **NO AUTOLAND**.
- FMC VNAV pages and performance predications. PFD flap manoeuvre speeds.
- Use AFDS basic modes. For the approach use ND VOR /APP modes. Use HDG SEL and V/S or raw data.
- A/P, A/T and FD are available.

NAVIGATION:

- ND map display changes from Heading up to Track up. (VOR /APP modes are always Heading up).
- FMC information is still available. It may be manipulated via the CDU and is displayed on the ND MAP as per normal. Use HDG SEL to keep aircraft on the magenta LNAV path. Good idea to have raw data tuned and displayed on one of the ND's.
- Use FMC Nav Rad page and ND VOR mode for radio navigation. (Fly airways by tracking from beacon to beacon). NAVRAD Preselect function is useful.
- If FMC MAP is not available for some reason.
  - For Oceanic/desert routing: use HDG SEL to keep the track on the ND map the same as that required to track the airway (CFP or Jeppesen chart). At the next reporting point, DR calculated using ETA; line - select the GPS position and plot it on the Jeppesen chart.
  - If flying west or east, the latitude will indicate if the a/c is north or south (left or right) of track.
  - If flying north or south; the longitude will indicate if the a/c is west or east of track.
  - Report to ATC that Navigation has been degraded as per **FOM 19.6.5.2**

APPROACH:

- Fly a raw data ILS (LOC /GS /TOGA modes are inop even though FD's are available) or use HDG SEL and VS - long final.
- **Go around (TOGA is not available):**
- Pitch towards 15 / 10 º NU and call for the appropriate go around flap.
- Disconnect A/T and set G/A thrust.
- Gear up.
- Select FD's on which appear in default HDG HOLD and VS modes.
- Engage A/P and A/T.
- At 400ft, engage HDG SEL and fly the LNAV track / go around procedure.
- Monitor the speed and adjust VS as required to fly Vref / + 15.
- At MAA, ALT engages. Set flaps up speed and retract the flaps. .Engage FLCH to give a pitch mode. (Gives climb thrust and A/T engages
- This is an Instrument Failure (**Boeing Divert to Good Weather**)

ADIRU AND SAARU TRANSMITTER FAILURE.

CONDITION:

- The interface between the ADIRU, SAARU and the Databus has failed. No ADIRU or SAARU information is available on the PFD's

REASON:

CHECKLIST:

NOTES:

- Similar to an ADIRU failure except that the PFD's are inoperative and manually selecting the AIR DATA / ATT source switches to ALTN doesn't restore air data and attitude information to the PFD's.
- **Raw Data, Standby Instruments, Manual Thrust, No Autopilot. No Flight Director, Secondary Mode**
- **Available instruments**:
  - Attitude information is available only on the standby horizon. (SAARU attitude)
  - Altitude info is available on the standby altimeter. Radio altimeter cannot be displayed.
  - Speed info is available on the standby ASI. (QRH. VREF chart.) GPS groundspeed is displayed on the ND.
  - ILS on PFD but only indices and CDI are showing

NAVIGATION:

- The ND displays GPS track information. Heading is displayed on the glare shield standby compass.
- FMC information is still available. It may be manipulated via the CDU and is displayed on the ND MAP as per normal. Just fly the aircraft symbol along the magenta 'brick road'. For the approach use the MAP mode cross checking with the PFD raw data ILS indices or use the VOR or APP mode.
- Engines are in alternate EEC mode, set 57 - 60% N1 and fly a pitch attitude of 0 - 1ºnu to fly the approach (F30 / 2 Engines).

CHECKLIST:

- The EICAS caution alert: **NAV ADIRU INERTIAL** is displayed.
- The **NAV ADIRU INERTIAL** checklist is not completely appropriate e.g. **the set heading line is never displayed on POS INIT** P1/3. Useful information is the list of inoperative items.
- Other EICAS:
  - **EEC MODE**
  - **AUTOPILOT**
  - **FLIGHT CONTROL MODE**
- This is an Instrument Failure (**Boeing Divert to Good Weather**)
- Declare a MAYDAY
- Land at an airport with very good weather.
- Cannot hand over control to CM2

AIR DATA

- The ADIRU and SAARU receive air data from the same sources (all the ADM's).
- Both the ADIRU and SAARU perform data validations, disregarding invalid data. i.e. 2 or all 3 of the 3 air data sources (3 pitot static systems) agree in the ADIRU, SAARU or both.
- Normally, with ADIRU air data valid and the AIR DATA / ATT S/W - norm, the ADIRU provides air data and attitude information to the PFD and ND.
- SAARU is available for automatic attitude and/or air data backup.
  - **If the ADIRU air data is invalid**
    - The SAARU is automatically selected to provide air data information to the PFD's and ND's.
  - **If ADIRU and SAARU air data is invalid**:
    - **EICAS Advisory: NAV AIR DATA SYS**
    - The ADIRU air data from the left pitot static system (LEFT CHANNEL) is displayed on the left PFD.
    - The SAARU air data from the right pitot static system (RIGHT CHANNEL) is displayed on the right PFD.
    - Centre pitot static system (CENTRE CHANNEL) is displayed on the standby displays. Standby displays do not use ADIRU or SAARU air data. SAARU attitude is displayed on the standby ADI.
    - The ADIRU continues to supply attitude information to the PFD's and ND's (AIR DATA / ATT s/w - norm).
    - This is the single channel condition. Information from air data sources is no longer being combined for display. Automatic fault detection is no longer available but the information is displayed separately and independently.
    - NB: The sources here are different - do not confuse with Single Source Displays (**SGL SOURCE DISPLAYS** where only one graphics generator remains functioning).

□ NAV AIR DATA SYS

CONDITION:

- Information from the air data sources is no longer being displayed

REASON:

CHECKLIST:

- Note: Avoid abrupt control inputs
- Crosscheck airspeed and altitude on PFD's and Stby Inst for accuracy
- Select Altn Air Data/ATT if airspeed or alt on respective PFD is determined to be in error and opposite side is correct
- Inop Items:
  - Autopilot
  - F/D
  - A/T
  - PFD Flap Maneuvering speeds
  - TAC
  - Auto Speedbrake
- Use flap 20 for landing

NOTES:

- ADIRU and SAARU air data is invalid.
- Degrades to Secondary Flight Control Mode (2° mode pitch laws do not depend on airspeed). Handling is degraded.
- **FLIGHT CONTROL MODE**
- **THRUST ASSYM COMP**
- **AUTO SPEEDBRAKE**
- **A/P, FD's and A/T inop**. – **RAW DATA**
- **AUTOPILOT**
- **NO AUTOLAND**
- **AUTOTHROTTLE**
- PFD has normal functions except manoeuvre speeds and FD's.
- FMC operates normally and information is available on the ND MAP mode.
- Basically, just fly the aircraft symbol along the magenta 'brick road'.
- Crosscheck airspeed and altitudes on the PFD's and standby displays for accuracy to find which PFD and therefore which channel is in error (ADIRU channel left or SAARU channel right).
- The SAARU and centre channel always supplies the standby instruments. (Attitude and air data respectively).
- Once the PFD with erroneous data has been established:
- Select the AIR DATA / ATT source switch on THAT side to ALTN. This selects the alternate air data and the alternate attitude for the PFD and ND on that side.
- Report to ATC that Navigation has been degraded as per **FOM 19.6.5.2**
- (**Boeing Divert to Good Weather**). There is air data but reasonable weather at destination will be prudent
- Share the flying to spread the workload
- PFD MANEUVRE SPEEDS (QRH. VREF chart. ZFW + TOT fuel).
- For the approach use the MAP mode cross checking with the PFD raw data ILS indices or use the VOR or APP mode. Flap 20-pitch attitude to fly a 3ºslope is 2.5ºnu. Set N1 of 55% for 2 engines and 62 % for I engine inop.
- If Capt AIR DATA / ATT s/w is put to ALTN
- Capt will get - SAARU single channel Right air data borrowed from the right. (SAARU air data from the R. Pitot Static system) and SAARU attitude (SAARU is the alternate attitude source).
- If F/O AIR DATA /ATT s/w is put to ALTN
- F/O will get - ADIRU single channel Left air data borrowed from the left (ADIRU air data from the L. Pitot Static system) and SAARU attitude (SAARU is the alternate attitude source).
- Standby flight instruments remain unchanged. They use Centre channel air data (Centre Pitot and Static system). They never use ADIRU or SAARU air data. SAARU supplies attitude information.
- If both AIR DATA / ATT sw/s are pressed to ALTN, EICAS advisory - **ALTN ATTITUDE**.
- Both PFD's now have SAARU attitude.

NAV UNABLE RNP ..... Caution Message with Beeper

CONDITION:

- Navigation performance does not meet required accuracy

REASON:

CHECKLIST:

NOTES:

SINGLE SOURCE ILS ..... Caution Message with Beeper

CONDITION:

- Both PFD's and ND's are using the same source for ILS information

REASON:

NOTES:

- Report to ATC that Navigation has been degraded as per FOM 10.pg9

TRANSPONDER L, R

CONDITION:

- Affected Transponder has failed

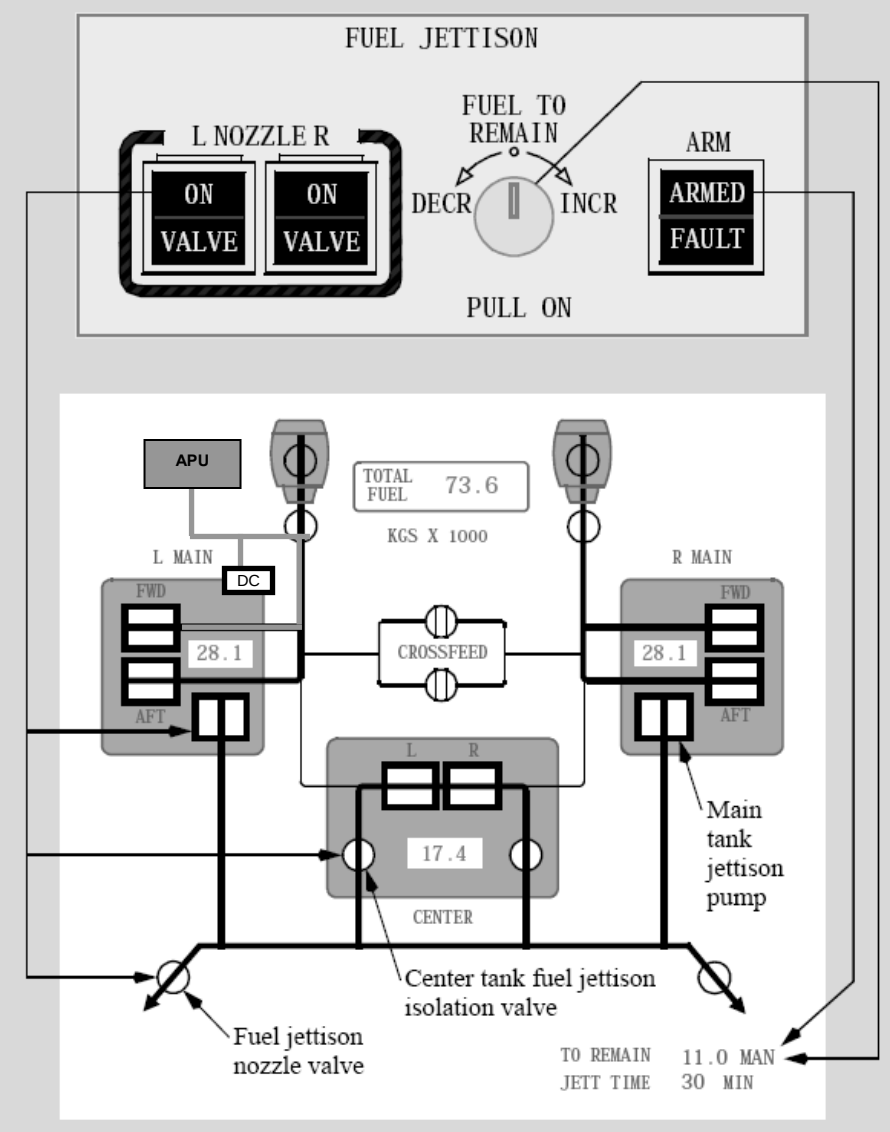
REASON:

NOTES:

- Switch to opposite transponder
- This may be as a result of an AC bus failure

INTENTIONALLY BLANK

12. Fuel Systems



- Center Fuel pumps have higher output pressure than main tanks and are used for fuel feed and fuel jettison.
- A DC fuel pump in the left main fuel tank feeds fuel to the APU until AC power is established.
- Jettison pumps in each main tank assist in jettisoning fuel from all 3 tanks.
- FQIS (Fuel Quantity Indicating System) utilizes height and density to calculate fuel quantity.
- Left forward fuel pump operates automatically to provide fuel to the APU regardless of switch position.
- Scavenge pumps automatically transfer any residual fuel from the center tank to the main tanks.
- Arming the Fuel Jettison system displays the fuel jettison synoptic.
  - Fuel to remain display replaces the fuel quantity/temp display
  - Fuel to remain display initializes at a weight that will leave the aircraft at MLW.
  - Fuel Jettison will start when Fuel Jettison nozzles are selected on.
  - Stand pipes in the main tanks ensure at least 5,200 kgs will remain in each main tank.
  - All center tank fuel can be jettisoned.
  - Fuel jettison automatically terminates when the fuel to remain target fuel is reached.

□ FUEL AUTO JETTISON ..... Caution Message with Beeper

CONDITION:

- Fuel Jettison Automatic Shutoff is Inoperative OR Total Fuel is LESS then FUEL TO REMAIN and One Nozzle Valve is Open.

REASON:

- This may be due to the fact that One or More Tank Quantity Indications is Blank so the Automatic Shutoff cannot operate without this data

NOTES:

- **Whenever dumping is to take place take note of the following:**
- Fuel in each tank
- Time to dump
- Time dump began
- This is because if the tank indicator fails halfway thru the dump, you will not know how much you have dumped
- The fuel dumping will have to be Manually Terminated by estimating the Time to Dump using:
- **2500 Kg / Min Jettisoning All Tanks**
- **1400 Kg / Min Jettisoning Main Tanks Only**
- When Jettisoning is Complete, turn OFF the Fuel Jettison Nozzle Switches and the Fuel Jettison Arm Switch.
- Some ways to help Jettison Calculations with no tank indication:
- Centre tank decreases at 1100 kgs/min. Therefore divide the centre tank fuel quantity by 1100 to calculate how long to jettison centre tank. The main tanks decrease at 1400kgs/min.
- If Centre tank quantity indications are inoperative: centre tank is empty when synoptic pump lights amber & fuel low centre message is displayed.
- Note: If fuel quantity indicators are inoperative, be conservative. Rather land a few tons overweight than jettison too much fuel, although the standpipes should protect against disaster.
- The FUEL Line on the PERF INIT Page may be Blank as it is set to Totalizer Value during fuel jettison and if there is no valid Totalizer Data a Manual Entry must be made for VNAV Operation. A Manual Entry can only be done 5 Mins after fuel jettison is complete. Enter current estimated total fuel in the fuel line box prompts on the PERF INIT page. This provides gross weight data for FMC calculations and allows VNAV to be re-engaged.
- **Stand pipes** ensure that a minimum of 5.2T of fuel remains in each main tank after fuel jettison. (10.4T total).
- An -IGW A/C at a max ZFW of 195.0 tons. To land at MLW of 208.6T, fuel remaining after fuel jettison will be 13.0T.
- An A market a/c at a max ZFW of 190.5tons. To land at MLW of 201.8T, fuel remaining after fuel jettison will be 11.0T.
- Therefore, assuming the worst case of the A/C at max ZFW, an -IGW a/c will have sufficient fuel for a 350nm diversion with full reserves whilst an A market a/c will have sufficient fuel for a 250nm diversion with full reserves.

□ FUEL CROSSFEED AFT, FWD

□ FUEL IMBALANCE

CONDITION:

REASON:

NOTES:

- The EICAS message FUEL IMBALANCE monitors the variable fuel imbalance limitation (1134 - 2041 depending on a/c gross weight).
- Access the maintenance display - SHOW FUEL and check the Fuel Height values, comparing Left with Right.
- If there is a disagreement between two probes, a white **X** is denoted next to the particular probe. This would produce an indication problem.
- If one engine was mechanically using more fuel than the other i.e. has higher fuel flow, then FMC Progress Page 2 Left and Right fuel used values would be different.
- If one wing kept losing fuel causing an imbalance refer to the fuel leak parameters.
- There is no need to rush into this checklist. The B777 flies well with very large imbalances in spite of the fuel imbalance limitations.
- When a **FUEL IMBALANCE** EICAS message is displayed, the fuel imbalance checklist should be performed at the appropriate time.
- Accomplish all applicable non-normal procedures prior to commencing final approach. **FCTM 1.33**
- The PF may direct reference procedures to be accomplished by recall if:
  - No hazard is created by such action,
  - The situation does not permit reference to a checklist.
- If this message occurs on the approach, strongly suggest that one does not do the checklist by reference or by recall. Leave the message displayed on EICAS (don't cancel). Do the checklist at an appropriate time after a missed approach.
- If the fuel imbalance checklist was initiated but not completed before the final approach began, recommend that the incomplete fuel imbalance checklist remain displayed after the Landing checklist has been completed. The icon should have disappeared off the EICAS since the checklist has been initiated. The EICAS messages should be cancelled.

FUEL IN CENTER

□ FUEL JETTISON MAIN

CONDITION:

- Fuel Jettison from the Main Tanks is inoperative

REASON:

NOTES:

μ FUEL JETTISON

CONDITION:

- Fuel Jettison is required

REASON:

NOTES:

- Always note the following before commencing Jettison: Fuel in Each Tank
- Time to Jettison
- Start Time of Jettison
- Press the stopwatch to time fuel jettison.
- Before fuel jettison, ensure that you are happy with that airport.
- Must have 2 runways or fuel for another airport (weather / approaches).
- The unannunciated checklist found in the unannunciated and fuel sections of the ECL/QRH.
- On the EICAS display, the TO REMAIN value replaces the fuel temperature indications. Monitor the total fuel value decreasing to the 'TO REMAIN' value.
- The time to jettison is displayed on the fuel synoptic. When the TO REMAIN quantity is reached, the TO REMAIN value flashes and the jettison time reads 0 mins.
- Fuel jettison rates are:
- ▯All tanks dumping -2500kgs/min ▯Main tanks only - 1400kgs/min.
- The centre tank fuel cannot be jettisoned if the centre tank fuel pumps are selected off because these are the pumps that do the jettisoning.
- If the air/ground sensor is inoperative i.e. in the ground mode: fuel jettison is inoperative.
- Carry out fuel jettison on a constant heading or if in a holding pattern by flying long in / outbound legs (10.0 nm leg distance) and by turning **into** wind during the turns.
- Minimum altitudes for fuel vaporisation are:
- Summer - 7000ft. Winter - 4000ft.
- If there are no other considerations use 10 000ft.

□ FUEL JETTISON SYS ..... Caution Message with Beeper

CONDITION:

- The Fuel Jettison System is Inoperative.

REASON:

NOTES:

- Put Both Fuel Jettison Nozzle Switches OFF and put the Fuel Jettison Arm Switch OFF. An Overweight Landing will have to be planned:
- Check Field Length Limit
- Approach and Landing Climb Limit
- Use Longest Runway Available
- Establish Early on Final
- Flight 20 Kts Below Man. Speed is permitted
- Initiate Stopping Immediately

FMC INSUFFICIENT FUEL

CHECK:

- Correct active waypoint
- Entered FMC winds.
- Fuel reserves.
- Route discontinuities.
- Check Totaliser fuel. When in the terminal area of destination, Totaliser fuel - 1 Ton should give FOD.
- Progress P2 - compare:
- Totalizer versus Calculated i.e. fuel qty sensed in tanks verses fuel qty calculated by fuel flow.
- Impact of fuel leak: Fuel disagree message on the CDU scratchpad (Totaliser and Calculated fuel disagree by 4100kgs in 5 mins)
- Impact of high fuel use (drag/time): Totaliser and Calculated values agree. Insufficient fuel message on the CDU scratchpad.
- Fuel used values on Progress P2 (calculated figures using the fuel flow meters) are higher than planned.
- Fuel used figures are calculated figures using the fuel flow meters.

μ FUEL LEAK

NOTES:

- Begins by establishing if a fuel leak does exist.
- One of more of the following may be evidence of a fuel leak:
  - Visual observation of fuel spray from strut / engine
  - Excessive engine fuel flow
  - Total fuel quantity decreasing at an abnormal rate
  - **FUEL IMBALANCE** EICAS message
  - **FUEL DISAGREE** message on the CDU scratchpad (disagree of 4100kgs in 5 mins)
  - **INSUFFICIENT FUEL** message on the CDU scratchpad.
  - Turn off the Center tank fuel pumps and the Crossfeed switches. This isolates the 3 fuel tanks. Now Main tanks should decrease while Center Tank remains static
  - Use Synoptic Page
  - Check the rate at which the **Total** and **Individual** fuel quantity decreases. It should decrease at about 7 tons per hour / 3.5T per 30 mins. If the **total** fuel quantity decreases at a rate greater than this, then consider a fuel leak. Therefore make a note of all 3 fuel tank quantities as well as the total fuel quantity. After 30 mins or an hour, recheck and note the individual tank quantities as well as the total fuel quantity. Check:
  - Rate at which total fuel quantity decreases. Is this reasonable?
  - Have the main tanks decreased at the same rate?
  - Has the center fuel tank quantity decreased?
  - If a tank has an imbalance which is worsening but the total fuel quantity is decreasing at the correct rate, fuel could be transferring from one tank to another say from a main tank to the center via the fuel jettison plumbing.
- The checklist leads you to trouble shoot where the fuel is leaking from the center fuel tank or the leak from an engine.
- **If B777-200A**
  - This part of the ECL only applies to the non-IGW aircraft.
  - If both main tank quantities decrease at the same rate:
  - The fuel leak may be from the center tank to the center wing area. It assumes that fuel may have leaked from the center interconnect tubes into the surrounding center tank dry bay.
  - Don't use center tank fuel. Don't turn on the center tank pumps, which will pressurise the system and make the leak worse.
  - On progress page 2, use calculated fuel quantity (using fuel flow) to calculate a/c gross weight.
  - (Leaked fuel is still on board in the center bay contributing to the gross weight of the a/c)
  - Verify adequate fuel available in the left and right main tanks to complete flight.
  - (Use EICAS totaliser fuel quantity i.e. measured fuel in tanks to calculate fuel available for use.)
- **Any B777**
  - If engine fuel leak is confirmed:
  - One main fuel tank decreasing faster than the other. An increase in fuel balance of 500kgs in 30 minutes should be considered a fuel leak. Conditions permitting visually check for engine fuel leak.
  - Use totaliser to determine fuel remaining.
  - Shutdown engine that has the engine fuel leak.
  - (Possible fire risk or risk of leaking out fuel to a point of great imbalance. Option of diverting to nearest suitable airport on 2 engines not given)
  - All remaining fuel (including center tank fuel) can be used for the operating engine. Plan to balance fuel when the fuel imbalance EICAS message displays.
  - Fuel leak is either from an engine or from the center fuel tanks. Boeing says a leak cannot come from the main tanks.

SUMMARY:

- B777 - 200A a/c can have leak from the center tank interconnect tubes into the dry bay or have an engine fuel leak.
- B777 - 200IGW a/c can only have an engine fuel leak.
- **Boeing say that a main tank fuel leak not possible.**
- Stay close to a suitable airport.
- This will be more critical on short sectors and is likely to occur close to destination.
- Determine your range based on fuel in One Main Tank.

□ FUEL PRESSURE ENG L, R ..... Caution Message with Beeper

CONDITION:

- The Engine is on Suction Feed.
- Thrust on the affected Engine may deteriorate during Climb at high altitude. If required thrust cannot be maintained then open a Crossfeed Valve.

REASON:

NOTES:

- QRH
- If operation is continued with a Crossfeed Valve Open then there will be a Progressive Fuel Imbalance due to both engines feeding from the same tank.

□ FUEL QTY LOW ..... Caution Message with Beeper

CONDITION:

- Fuel Quantity is Low in EITHER Main Tank. Fuel Quantity is **2041 Kg**. or Less in Either Main Tank.

REASON:

NOTES:

- QRH
- All Fuel Pump Switches must be put ON and Either Crossfeed Valve ON. This ensures that All Possible Fuel is available and fuel is available to Both Engines should the Low Tank Empty. Nose
- High Attitudes and Excessive Acceleration must be avoided to prevent the Forward Fuel Pumps from uncovering.
- FCTM
  1. Maintain clean configuration as long as possible to conserve fuel.
  2. Slowly decelerate and configure to avoid fuel from running fwd.
  3. Use normal landing configuration
  4. Avoid heavy braking and reverse thrust to prevent uncovering pumps resulting in a flameout.
  5. G/A - Apply Thrust Slowly. Use min. Nose up Attitude.

□ FUEL PUMP CENTER L, R

CONDITION:

REASON:

NOTES:

- QRH
- If both L and R pumps are not providing pressure, then center fuel is not available, as center tank will not suction feed.

□ FUEL PUMP L AFT, FWD

□ FUEL PUMP R AFT, FWD

□ FUEL TEMP LOW

CONDITION:

REASON:

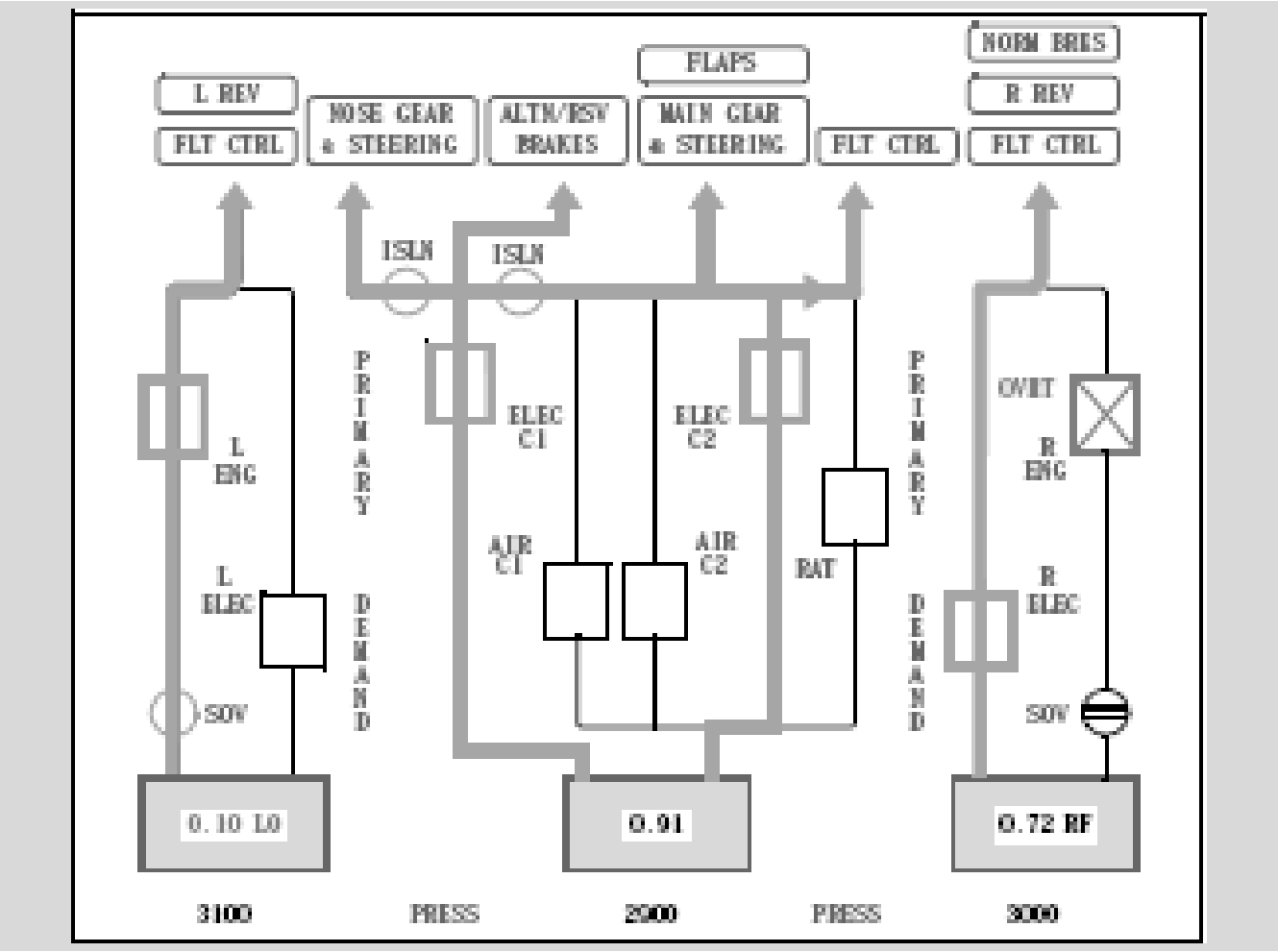
NOTES:

- FCTM

FUEL JETT NOZZLE L, R

□ FUEL VALVE APU

13. Hydraulics & RAT Systems



- Hydraulic pump FAULT lights illuminate for low pump pressure or high pump fluid temperature.
- After engine start the right demand pump stays on until the aircraft is airborne.
- The left demand pump is commanded on above 60 knots.
- Left and right demand pumps are commanded off above 60 feet RA.
- The C1 and C2 demand pumps turn during the take-off roll to be ready for gear retraction.
- The center demand pumps turn off after landing gear is retracted.
- When gear is extended only one center demand pump turns on.
- For abnormal operation when the center system is isolated. After landing the left isolation valve will open up below 60 knots and allow nose gear steering.
- The RAT will automatically deploy if the L/C/R hydraulic system pressures are low or if both AC transfer busses are unpowered.
- RAT supplies hydraulic pressure to the center hydraulic system Flight Controls.

□ HYD AUTO CONTROL C

CONDITION:

- Both Center Demand Pump AUTO functions and all center hydraulic system indications are inoperative

REASON:

- Both Center System HYDIM Modules have failed

NOTES:

- If additional hydraulic problems occur on that system there may be no indication of this
- The center system will not attempt to isolate hydraulic leaks
- Automatic deployment of the RAT will not occur

□ HYD AUTO CONTROL L, R

CONDITION:

- Demand Pump AUTO function and all left or right hydraulic system indications are inoperative

REASON:

- The respective HYDIM Module has failed

NOTES:

- If additional hydraulic problems occur on that system there may be no indication of this

□ HYD OVERHEAT DEM L, R, C1, C2

CONDITION:

- Demand Pump temperature is high

REASON:

NOTES:

- If this is subsequently followed by a **HYD SYS PRESS** on the same system, there is little point in putting this pump back on again as it will cure the system pressure problem, but will then overheat and have to be turned off again. This will once more bring up the **HYD SYS PRESS** message and the loop will be repeated.
- Perhaps one attempt at this is sufficient then accept the system pressure loss

□ HYD OVERHEAT PRI C1, C2

CONDITION:

- Primary Pump temperature is high

REASON:

NOTES:

- If this is subsequently followed by a **HYD SYS PRESS** on the same system, there is little point in putting this pump back on again as it will cure the system pressure problem, but will then overheat and have to be turned off again. This will once more bring up the **HYD SYS PRESS** message and the loop will be repeated.
- Perhaps one attempt at this is sufficient then accept the system pressure loss

□ HYD OVERHEAT PRI L, R

CONDITION:

- Primary Pump temperature is high

REASON:

NOTES:

- If this is subsequently followed by a **HYD SYS PRESS** on the same system, there is little point in putting this pump back on again as it will cure the system pressure problem, but will then overheat and have to be turned off again. This will once more bring up the **HYD SYS PRESS** message and the loop will be repeated.
- Perhaps one attempt at this is sufficient then accept the system pressure loss.

□ HYD PRESS DEM L, R, C1, C2

CONDITION:

- Demand Pump output pressure is low when commanded on

REASON:

- The pump may have failed or the Auto Demand function may have failed

CHECKLIST:

NOTES:

- If the C1 or C2 Demand pump has failed (ADP) and the flaps are not up, Approach Idle is selected

□ HYD PRESS PRI C1, C2

CONDITION:

- Primary pump output pressure is low

REASON:

CHECKLIST:

- Turn off the pump to prevent system contamination and/or damage

NOTES:

□ HYD PRESS PRI L, R

CONDITION:

- Primary pump output pressure is low

REASON:

CHECKLIST:

- Turn off the pump to prevent system contamination and/or damage

NOTES:

- The Thrust Reverser on the affected side may be inoperative due to the demand pump not being able to handle the load
- **TECHNICAL EXPLANATION - C HYD SYSTEM ISOLATION**
  - If a leak occurs and airspeed is greater than 60kts; when a low quantity condition is sensed (Qty @ 0.4), both isolation valves close. The C1 electric/primary pump is isolated and will operate regardless of switch position. The ALTN/RSV brakes and nose gear & steering are isolated from the rest of the Centre hydraulic system.
  - The leading edge slats are isolated and not allowed to operate in the primary (hydraulic) mode. If the system (CHIS) determines that both engines are running, the LE slats are reconnected to the C hydraulic system within a few seconds and can operate in the primary mode. The reason for this is to preserve remaining C system hydraulic fluid in case the low quantity condition was caused by an uncontained engine failure that may have damaged hydraulic lines supplying the leading edge devices.
  - If the hydraulic quantity continues to decrease to the standpipe level (Qty @ 0.0), the isolation was unsuccessful and the leak is assumed to be elsewhere.
  - The left isolation valve re-opens so that the nose gear and steering and the ALTN/RSV brakes have hydraulic fluid.
  - If after isolation the quantity does not reduce further and hydraulic pressure remains normal i.e. the isolation was successful (i.e. leak could be in the ALTN / RSV brakes line), the isolation valves remain close and only open when:
  - Landing gear down and
  - L and R primary pumps are providing pressure.
  - However, below 60kts after landing the left isolation valve opens to power the nose gear steering.
  - If the reservoir has a leak all the fluid may leak out. This means that even the nose gear and steering and the ALTN/RSV brakes will not have sufficient hydraulic fluid to operate.
- **LOSS OF ADP's.**
  - EICAS messages **HYD PRESS DEM C1** & **HYD PRESS DEM C2** or **BLEED LOSS BODY** indicates that the ADP's are not powered. Flaps and Slats may go to secondary mode and the **FLAPS PRIMARY FAIL**, **SLATS PRIMARY FAIL** messages will be displayed due to high hydraulic demand during flap retraction / retraction. Gear retraction will take 3 minutes. If an engine is inoperative, **avoid high terrain airports / high-density altitude airports**. Try to opt for an ILS, good weather etc and get an early landing clearance.

□ HYD PRESS SYS C ..... Caution Message with Beeper

CONDITION:

- Centre hydraulic system pressure is low.

REASONS:

- All the C system pumps have failed – unlikely situation.
- C system user has leaked out the fluid.
- C system reservoir has a leak.
- Conditions and above may also cause the EICAS advisory message **HYD QTY** LOW C to be displayed.
- Use EICAS, the HYD synoptic and the illuminated amber fault lights on the overhead hydraulic panel to determine the cause.

CHECKLIST:

- Attempts to restore system pressure by turning one of the Demand pumps (ADP) on in case the AUTO function had failed.
- Inoperative items:
  - **Main landing gear hydraulic system**.
  - Main gear steering.
- Plan **additional time for slower slat and flap operation.** (Slats and flaps are in the secondary / electric mode).
- Use **flaps 20 and Vref20** for landing.

NOTES:

- Flaps and slats are driven electrically through the FSEU's. Power source is the L & R Main AC Buses.
- Use the flap lever.
- Do not reduce airspeed too early
- Slats are fully extended at all flap positions. However if they were in the midrange position when the secondary mode engaged, they remain in that position until the flaps are retracted to up or are extended beyond 20.
- If flaps are retracted, no problem to continue however liaise with engineering and consider destination / company requirements.
- **Main Gear Steering:** Consideration should be given as to how to exit the runway. The biggest radius turn exit/ high speed turnoff - type exit is required. Company should anticipate towing a/c off the runway.
- **During flap retraction:**
  - Set the maneuver speed for the flaps called for. E.g. Retracting from 5 to 1, set flap 1 maneuver speed.
  - When above MSA, / have advised ATC and situation allows, accomplish the **HYD PRESS SYS C** checklist.
  - Retract the flaps using the secondary mode.
  - When flaps have retracted to 1, set flaps up speed retract flaps (Slats). When flaps up engage VNAV or accelerate as required.
- **During flap extension:**
  - Slats go to full extend at the flap 1 position.
  - Flap operation is slow: 0-5 takes 4minutes and 5-20 takes 1minute. Planning is crucial – extend flaps to 20 prior to the FAF/FAP.
  - Use flap 20 for landing. Set Vref 20 for landing.
  - Select the flap, once it has travelled then set the manoeuvre speed.
  - Fly the manoeuvre speed until on final approach and then set the landing speed. (E.g. For flaps 20 landing, set Vref30+20 until on final approach then set Vref 20 for landing).
  - Pitch attitude on a 3ºslope is 2½ºnu.
  - Flaps to remain at Flap 20 for go-around.

- **Landing Gear:**
  - Use **alternate gear extension** (Electric hydraulic pump using residual/minimal C. system fluid releases all landing gear and doors uplock hooks - gear free falls).
  - No truck tilt. Gear doors remain open - EICAS Gear Doors.
  - **Cannot retract gear.**
  - Suggest extending flaps to 20 prior to the FAF/FAP or in the hold. At FAF/GS capture - gear down (Landing assured i.e. landing clearance received.)
  - **Good planning required.**
  - Good weather to ensure a landing. If there is any chance of a missed approach consider:
  - Consider diverting to an airport that has good weather and no high terrain on the missed approach.
  - Fuel required for an alternate airport close by within gear down range.
  - Landing gear cannot be retracted. Only extend it when landing assured. Advise ATC and ask for an early landing clearance.
  - With an engine inoperative, it is critical that the landing gear only be extended when landing assured. E.g. runway visual, a/c in the slot and landing clearance received. Therefore good weather is essential. Do not attempt a go - around.
  - For non-normal configuration, do not land above MLW. (unless fuel rqd for a gear down diversion puts you slightly above MLW).
  - Accomplish all applicable non-normal procedures prior to commencing final approach. **FCTM 1.33**
  - The flaps and landing gear extension drill (deferred items) may be deferred to the approach checklist. Can access the approach checklist and go through the recall and notes plus the deferred items to remind you of what items still need to be accomplished.

□ HYD PRESS SYS L ..... Caution Message with Beeper

CONDITION:

- Left hydraulic system pressure is low.

CHECKLIST:

- Attempts to restore system pressure by turning on the Demand pump in case the AUTO function had failed.
- Inoperative items:
- Left Thrust Reverser is inoperative
- Roll rate may be reduced in flight.

□ HYD PRESS SYS L+C ..... Caution Message with Beeper

CONDITION:

- Left and center hydraulic system pressures are low.

REASON:

CHECKLIST:

- Handling qualities are degraded.
- **Land at nearest suitable airport.**
- Inoperative items:
- Multiple flight control surfaces
- **Main landing gear hydraulic operation.**
- Left Thrust Reverser.
- **Main gear steering.**
- Plan **additional time for slower slat and flap operation.** (Slats and flaps are in the secondary / electric mode).
- **Flaps 20. Set Vref30 +20.**
- **Crosswind limit is 20 knots.**

NOTES:

- **FLIGHT CONTROLS:** This EICAS message means that multiple ACE and/or hydraulic system failures cause the loss of a significant number of control surfaces or other flight control system faults are detected.
- Fewer operating control surfaces means handling quality will be degraded.
- Ailerons and left elevator inoperative.
- right elevator, both Flaperons (R & C) and the rudder are operating.
- Only 2 spoilers pairs are operating.
- Loss of L & C leaves a/c with the **least operable flight controls compared to the other dual hydraulic failures.**
- **Landing Gear:** [Refer to Hyd C notes]. Use alternate gear extension. No truck tilt. Gear doors remain open - EICAS **GEAR DOORS**. **Cannot retract gear.**
- **Flaps:** [Refer to Hyd C notes] Electric flap operation. Slow, 0-5 takes 4mins. 5-20 takes 1min.
- **Main Gear Steering:** Consideration should be given as to how to exit the runway. The biggest radius turn exit/ high speed turnoff - type exit is required. Company should anticipate towing a/c off the runway.
- See **HYD PRESS SYS C** notes for **planning.**
- **NO AUTOLAND**

HYD PRESS SYS L+C+R ..... Caution Message with Beeper

CONDITION:

REASON:

NOTES:

□ HYD PRESS SYS L+R..... Caution Message with Beeper

CONDITION:

- Left and Right hydraulic system pressures are low

REASONS:

- All the pumps have failed – unlikely situation.
- System user has leaked out the fluid.
- System reservoir has a leak.

CHECKLIST:

- Do not exceed .87M (-EMM / EMN).
- Handling qualities are degraded.
- **Land at nearest suitable airport.**
- Inoperative items:
- Multiple flight control surfaces
- Left and Right Thrust Reversers.
- Autobrake
- **Normal brakes**
- **Flaps 20. Set Vref30 +20.**
- **Crosswind limit is 20 knots.**

NOTES:

- **FLIGHT CONTROLS:** This EICAS message means that multiple ACE and/or hydraulic system failures cause the loss of a significant number of control surfaces or ‖other flight control system faults are detected.
- Fewer operating control surfaces means handling quality will be degraded.
- Alternate brakes powered by the Center hydraulic system are available.
- This condition generally requires the longest landing distance on Non Dry Runways

□ HYD PRESS SYS R ..... Caution Message with Beeper

CONDITION:

- Right hydraulic system pressure is low.

CHECKLIST:

- Attempts to restore system pressure by turning on the Demand pump in case the AUTO function had failed.
- Inoperative items:
- Right Thrust Reverser is inoperative
- **Autobrake**
- Normal brakes
- Roll rate may be reduced in flight.

□ HYD PRESS SYS R+C ..... Caution Message with Beeper

CONDITION:

- Right and Centre hydraulic system pressures are low.

REASONS:

- All the pumps have failed – unlikely situation.
- System user has leaked out the fluid.
- System reservoir has a leak.

CHECKLIST:

- Do not exceed .87M (-EMM / EMN).
- Handling qualities are degraded.
- **Land at nearest suitable airport.**
- Inoperative items:
- Multiple flight control surfaces
- **Stabilizer**
- **Main landing gear hydraulic operation.**
- Right thrust reverser.
- Autobrake
- **Normal and alternate brakes**
- **Main gear steering.**
- Plan **additional time for slower slat and flap operation.** (Slats and flaps are in the secondary / electric mode).
- **Flaps 20. Set Vref30 +20.**
- **Crosswind limit is 20 knots. [**

NOTES:

- **FLIGHT CONTROLS:** This EICAS message means that multiple ACE and/or hydraulic system failures cause the loss of a significant number of control surfaces or ǁother flight control system faults are detected.
- Fewer operating control surfaces means handling quality will be degraded.
- Ailerons, stabilizer and rudder are operating. Flaperons inoperative. Only 3 Spoiler pairs are operating.
- **STABILIZER:** The stabilizer is powered by the R and C hyd systems. If both stabilizer modules have automatically shutdown fail unable to stop uncommanded motion then the EICAS warning message **STABILIZER** is displayed.
- Stabilizer warning is replaced with the advisory message **STABILIZER CUTOUT** when both cutout switches are in cutout.
- Pitch trim till available - the PFC's reposition the elevators to trim the aircraft (Normal flight control mode).
- **Landing Gear:** [Refer to Hyd C notes]. Use alternate gear extension. No truck tilt. Gear doors remain open - EICAS Gear Doors. Cannot retract gear.
- **Flaps:** [Refer to Hyd C notes] Electric flap operation. Slow, 0-5 takes 4mins. 5-20 takes 1min.
- **Normal and Alternate brakes:** Reserve brakes are still available (C hydraulic system isolation). If they were not available then the EICAS message **BRAKE SOURCE** would alert you that only accumulator pressure is available for braking.
- See HYD PRESS SYS C notes for **planning.**

HYD QTY LOW L, C, R

CONDITION:

- Hydraulic quantity is low.

REASONS:

- System user has leaked out the fluid.
- System reservoir has a leak.

NOTES:

- **Don't switch off the hydraulic pumps - stick to the checklist.**
- Bear in mind that using hydraulic systems could cause the leak to worsen to a **HYD PRESS SYS C / L / R** condition. Therefore plan ahead.

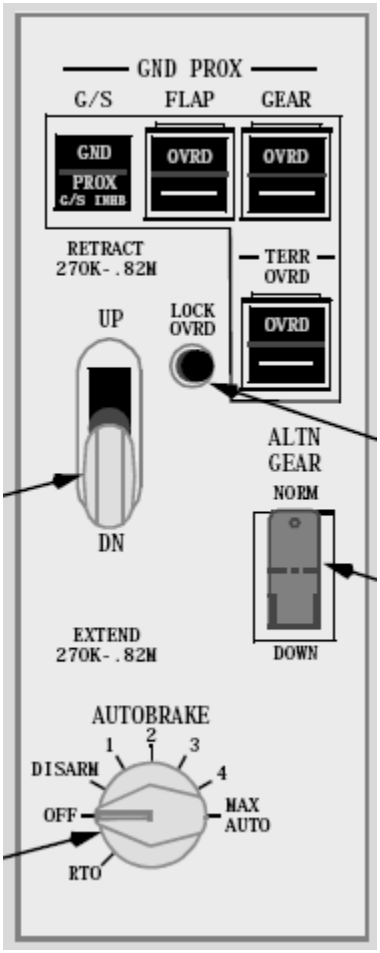
RAT UNLOCKED

CONDITION:

REASON:

NOTES:

14. Landing Gear Systems



Landing Gear Operation

- Main landing gear tilt for retraction and after extension.
- Aft pair of wheels is steerable.
- Center hydraulic pressure operates the Gear locks, doors, and gear.
- Hydraulic pressure is removed once the gear is up and locked.
- Once unlocked the gear free falls to the extended position.
- After takeoff you can not raise the gear lever if the ground sensing system remains in the ground mode.
- Landing gear lever lock override switch unlocks the landing gear lever in any phase of flight.
- Alternate Extension system uses an electrically powered hydraulic pump and center system hydraulic fluid to unlock the landing gear and landing gear doors.
- In Alternate extension mode there is no sequencing of doors and gear. Landing gear will not tilt.
- Gear doors will remain open after alternate extension.
- Gear may be retracted after alternate extension if center hydraulic pressure is available.

Nose and main gear steering

- Rudder pedals turn nose wheel 7º, Tiller turns the nose wheel 70º. Tillers will override the rudder pedals.
- Main gear aft axel steering operates when nose wheel turned approximately 13º.
- **MAIN GEAR STEERING** EICAS message occurs when main gear aft axel is unlocked when it should be centered.
- If the center hydraulic system fails reserve fluid from the center system powers nose wheel steering.

Tail Skid

- Only on the 777-300.
- Retracts and extends with landing gear. Powered by the center hydraulic system.
- **TAIL SKID** EICAS message means the tail skid position disagrees with the landing gear position.

Brakes

- Main gear wheels have carbon brakes. Nose gear wheels do not have brakes.
- Normal brakes are powered by the right hydraulic system. The right hydraulic system also powers the brake accumulator
- The alternate reserve brakes are powered by the center system when the normal brake system is not working.
- Accumulator pressure can be used on the parking brake or the normal brakes.
- Anti skid protection is provide in both normal and alternate systems.
- If the parking brake is set when the pressure is in the caution range the parking brake memo will display; however, the brakes will not be set.
- The parking brake uses all three sources of pressure. The priority is Normal, alternate, accumulator.
- **BRAKE SOURCE** light will illuminate if there is no pressure in the right and center hydraulic systems.
- RTO autobrake can only be selected on the ground.
  - Brake pressure is applied after thrust levers closed above 85 knots.
- RTO can be disengaged by:
  - Rotating the selector to off.
  - Advancing the thrust levers.
  - Stowing the speedbrake lever.
  - Applying manual brakes.
- Landing autobrakes are applied after:
  - Thrust levers at idle.
  - Wheel spinup.
- **ANTI SKID** EICAS message only appears after 2 antiskid sensors have failed.
- The Taxi Brake Release system operates from the normal brake system. If the wheel speeds are less than 45 knots the antiskid system releases the brakes of one axle pair of each main landing gear. The system sequences through the axel pairs at each brake application.

□ ANTISKID

CONDITION:

- A fault is detected in the antiskid system.

REASON:

CHECKLIST:

- Autobrake system is inoperative.
- Use minimum braking consistent with runway conditions to reduce the possibility of tire blowout.

NOTES:

- QRH
- Autobrake system is inoperative
- Use minimum braking consistent with runway conditions to reduce chance of tire blow-out.
- **FCTM:**
  - Ensure Nose wheel is on the ground and speed brakes are up before applying brakes
  - Use partial pedal inputs – approx 1/3 pedal travel. Increase in pedal input may be necessary
  - Apply steady pressure and do not pump brakes
  - Antiskid off braking requires even greater care during lightweight landings.
- At Dispatch
  - If dispatching with a Brake Deactivated or Locked Out refer to MEL
  - **To be completed: Need MEL.**
  - Note - special performance charts are required; Gear Down for 2 min after takeoff or gear up depending on MEL requirement
  - Don't forget to retract the Gear after 2 mins if distracted
  - Landing distances will be increased. Check Perf Dispatch to ensure landing distances are still adequate considering Weather and Notams for destination and alternate.
  - After start complete the ANTISKID checklist

AUTOBRAKE

CONDITION:

REASON:

NOTES:

□ BRAKE SOURCE

CONDITION:

- Normal, Alternate and Reserve Brakes are not available

REASON:

- Right or Centre hydraulic systems are not pressurizing the brakes

NOTES:

- Accumulator Pressure only is available
- The centre system has failed to isolate and preserve the reserve brakes after a Right and Centre Hydraulic system failure.
- Antiskid is provided in all 4 braking systems.
- Choose a long, dry runway though braking distances should not be affected
- Nose gear steering will probably not work. Arrange a Tow Truck
- Park Brake may be set provided that the accumulator pressure is above 1000 after stopping. Suggest chocking.
- QRH
- Apply steady increasing brake pressure and hold to a full stop
- Do **NOT** taxi (accumulator may run out)

□ BRAKE TEMP

CONDITION:

- Temperature of one or more brakes is excessive.

REASON:

CHECKLIST:

- In-flight: Extend the gear, when **BRAKE TEMP** message no longer displayed, wait a further 8 minutes then retract the gear.
- Ground: Refer to the brake-cooling table.

NOTES:

- **On Ground**
  - Scenarios. After RTO or After Landing
  - Clear the Runway
  - Refer to Brake cooling schedule
  - Brake Cooling Schedule
  - Due to brake cooling fans, on EK aircraft the BTMS is only accurate when:
  - Landing gear is retracted or
  - When parked after the fans have stopped running.
  - Brake temperature monitor system (BTMS) indication on EICAS may be used 10 - 15 minutes after the aircraft has come to a complete stop, or in-flight with gear retracted to determine the recommended cooling schedule.

□ GEAR DISAGREE ..... Caution Message with Beeper

CONDITION:

- Gear position disagrees with landing gear lever position

REASON:

NOTES:

- The expanded gear position indication displays the position of each landing gear:
  - UP - the associated landing gear is up and locked.
  - Crosshatch - the associated landing gear is in transit.
  - Empty box - the associated landing gear position indicators are inoperative.

CHECKLIST: During Retraction

- **If landing gear lever up:**
  - Observe the gear extend limit speed (270/.82M) [From the Gear Door checklist]
  - Flight with gear down increases fuel consumption and decreases climb performance - refer QRH Performance Inflight Gear Down performance tables.
  - FMC is unpredictable Use PI – Gear Down
  - Continue or return. Continuing will have a huge penalty and the gear may not come down.
  - Usually best to return unless weather poor or departure airport has terrain difficulties.
    - **Option 1:** return to departure airport. (Consider weather and chance of successful return. Terrain / missed approach gradient).
    - **Option 2:** continue to destination. (Sufficient fuel?)
    - **Option 3:** enroute airport.
- Get to a good airfield, as a Partial Gear Up Landing will probably be made. Wx, RFF
- Contact Engineering
- Try Cycling Gear – **Maybe not** – checklist does not suggest this. Try to ask engineering
- Is gear up or in transit?
- **Fuel required to continue: (assuming at MLW)**
  - 100nms: 5.2T + 1.0 + 6T (30mins holding) = 12.2T / **12.5 T** minimum. [FL190 / FL 200 Time 0:30 Vref30 + 80]
  - 200nms: 9.6T + 1.0T + 6T(30mins holding) = 16.6 / **17.0 T** minimum. [FL 210 / FL 220 Time 0:55 Vref30 + 80]
  - 400nms: 16.6T + 1.0T + 6T(30mins holding) = 23.6 / **24.0 T** minimum.[FL 210 / FL 220 Time 1:35 Vref30 + 80]
- Altitude / performance capability enroute terrain, missed approach gradient at airport of departure and destination.
  - At MLW max altitude - FL 220 / FL 230.
  - At MTOW, max altitude - FL 120 / FL 130.

CHECKLIST: During Extention

- If landing gear **lever** DN:
- Observe the gear extend limit speed (270/.82M) [From the Gear Door checklist]
- Alternate gear switch - down.
- Push and hold for 1 second. [Releases gear uplocks and gear door locks allowing gear to free-fall]
- If any gear remains UP or in transit:
- Remainder of the checklist deals with preparation to land on the available gear.
- Use available gear for landing
- Use flaps 30 for landing to lower landing speed
- Do not arm speedbrake lever – manually extend speedbrake after landing
- This would normally occur when preparing to land.
- Go-around, enter the hold and accomplish the GEAR DISAGREE checklist.
- If you were short of fuel say at your alternate airport then consider selecting Alternate gear switch - Down by recall.
- Enter the hold and accomplish the GEAR DISAGREE checklist.
- Study the **FCTM 8.20** landing technique for your specific landing configuration.
- Determine if this is a suitable airport in terms of weather / runway length / facilities (emergency and maintenance).
- Do you have the fuel to go elsewhere with the gear up / down as appropriate.
- Contact **Engineering** for assistance.
- Pulling G and sideslipping – for extension? Ask Engineering
- Cycling the landing gear is not in the checklist and could worsen the situation.
- Get out the **FCTM 8.21** and read useful info on Partial or All Gear Up Landing.
- Brief Purser (NITS). Prepared landing emergency and evacuation.
- PA to passengers.
- In all cases, reduce weight as much as practical by burning off or jettisoning fuel to provide the slowest possible touchdown speed. Minimum damage will occur it the airplane is kept on a paved surfaced landing area.
- Do not use foam.
- Briefings and crew co-ordination important.
- Brief F/O for Fuel Control Cut-off Switch See (FCTM)
- Accomplish the GEAR DISAGREE checklist to prepare for landing.
- When at pattern altitude: depressurize the a/c and turn off the fuel pumps.
- Hold the checklist at "When at pattern altitude:" until fully prepared to begin the approach.
- Initiate passenger evacuation. (FCTM).
- FOM
- Call purser to the flight deck **“Will the Purser report to the Flight Deck”**
- Purser will prepare cabin correctly
- 2 mins prior to landing **“Attention Crew at Stations”**
- 30 secs before touchdown **“Brace, Brace”**
- Landing should be made on whatever gear is available to reduce fire risk
- Low flypast should not be conducted unless there is evidence that this will help

□ GEAR DOOR

CONDITION:

- One or more gear doors are not closed

REASON:

CHECKLIST:

- Observe the gear EXTEND limit speed (270kts / .82M).

NOTES:

- QRH – Do not exceed 270/.82 M. This will require speed intervention in VNAV or FLCH. Then put the correct speeds in the FMC. Note, be careful about putting M.82 into the FMC as the FMC will target this in the cruise.
- Cycling the landing gear - could cause worse problems i.e. gear disagree.
- Implications of continued flight versus returning.
- No documented fuel / drag penalties.
- FMC performance predictions will be unreliable – refer to PI Gear Down for a conservative approach
- There will be a performance penalty but not huge – certainly less than with gear down
- This could well be connected to further landing gear problems, therefore avoid airports which could contribute to a gear down missed approach gear down diversion / partial gear up landing. (Consider weather / precision approach / number of runways / terrain).
- Long haul flight - slow speed / fuel rqts / stress on gear doors.
- FCTM: 3.11 Avoid using gear for drag above **200kts** as this will reduce gear door life
- Ask engineering where they want the aircraft to go

μ GEAR LEVER LOCKED DOWN

CONDITION:

- Landing gear lever cannot be positioned to up.

REASON:

- Possible causes are but not limited to failure of air/ground sensors on the main beams or failure of the solenoid in the lock override.

ACTION:

- Initially leave the landing gear down unless an engine failure occurs and / or performance requires that the gear be raised.
- Consider using basic modes to accelerate i.e. when VNAV engages and begins the acceleration, intervene by setting the flaps up speed and engaging FLCH at flap 1 as per normal.
- After flap retraction read the unannunciated GEAR LEVER LOCKED DN checklist.

CHECKLIST:

- Landing Gear Lever Lock - Push and hold
- Landing Gear Lever - Up.

NOTES:

- If landing gear stuck down due to failure of air/ground sensors other inoperative systems / indications include:
  - Status messages include - Air / Gnd sensor Door flight locks unlocked.
  - TCAS fail.
  - Fuel Jettison. (Since fuel jettison cannot operate on the ground). The EICAS messages FUEL JETT NOZZLE L/R are displayed. These messages have no icons but the condition statement reads: jettison nozzle valve is not in the commanded position. Therefore commit to an airport (have another runway available). Land overweight (F20 or F30/25) or burn off fuel. Landing with less than 20.0T overweight requires only a minor check. Consider number of engines operating / go around gradient / weather / number of runways etc.
  - Pressurization. Aircraft will not pressurize. Cabin Altitude Warning at 10 000ft. Cabin can be maintained manually but workload is high. (Use the table in the Cabin Altitude Auto ECL).

□ MAIN GEAR BRACE L, R ..... Caution Message with Beeper

CONDITION:

- Affected main gear is down with one brace unlocked.

REASON:

NOTES:

- QRH
- Use flaps 30 for landing to lower landing speed
- Do not arm speedbrake lever – manually extend speedbrake after landing
- FOM
- Call purser to the flight deck **"Will the Purser report to the Flight Deck"**
- Purser will prepare cabin correctly
- o 2 mins prior to landing **"Attention Crew at Stations"**
- 30 secs before touchdown **"Brace, Brace"**
- Low flypast should not be conducted unless there is evidence that this will help
- FCTM
- Prepare for a **possible landing gear collapse**.
- Get out the **FCTM 8.21** and read useful/applicable info on Partial or All Gear Up Landing techniques.
- Reduce Weight
- Determine if this is a suitable airport in terms of weather / runway length / facilities (emergency and maintenance).
- Do you have the fuel to go elsewhere with the gear up / down as appropriate.
- Contact Engineering for assistance.
- Brief Purser (NITS). Possible gear collapse and evacuation.
- Prepare Cabin for POSSIBLE prepared evacuation
- PA to passengers.
- In all cases, reduce weight as much as practical by burning off or jettisoning fuel to provide the slowest possible
- touchdown speed. Minimum damage will occur it the airplane is kept on a paved surfaced landing area.
- Briefings and crew co-ordination important.
- Set Park Brake and DO NOT taxi aircraft.

MAIN GEAR STEERING

CONDITION:

- Main gear steering is unlocked when centered.

REASON:

NOTES:

- Stop aircraft, read the unannunciated checklist condition statement, check MEL.
- If takeoff is attempted - Configuration warning - gear steering
- This problem will prevent dispatch under the MEL

□ RESERVE BRAKES/STRG

CONDITION:

- reserve brakes, normal nose gear extension and nose wheel steering may not be available

REASON:

NOTES:

- QRH
- Plan for possible Alternate Gear Extension
- Do Not taxi with loss of steering
- Give plenty of time or space for alternate gear extension
- Use GEAR DISAGREE Checklist for alternate gear extension. Should appear on EICAS / checklist queue if nose wheel does not extend.
- Stop on the runway or exit via the high-speed turnoff and then stop.
- Tow truck to get aircraft off the runway
- Brakes - normal brakes (R hydraulic system) is available. If at anytime hydraulic braking is not available the EICAS message BRAKE SOURCE is displayed.

TAIL SKID

CONDITION:

REASON:

NOTES:

TIRE PRESS

CONDITION:

REASON:

NOTES:

- Use Synoptic to determine Low or NO Tire pressure
- LOW tire press – Little Impact
- NO tire press – Tire has possibly burst
- Consider Airframe Damage
- Consider Debris on Runway
- If there are other malfunctions or vibrations – consider airframe damage and possibility of a return.
- Check Hydraulic Quantities
- If there is evidence of damage consider returning weather and performance permitting
- FOM says captains should be reluctant to continue as damage may show up later
- Consider extending the gear early to ensure that it does extend
- If tire explodes in wheel well the ramifications may be:
- Loss of Hydraulic Qty or Sys Pressure
- Wheel Well Fire
- Gear Disagree

15. Warning Systems & Tailstrikes

AIRSPEED LOW ..... Caution Message with Beeper

CONDITION:

- Airspeed is below minimum maneuvering speed

NOTES:

ALTITUDE ALERT ..... Caution Message with Beeper

CONDITION:

- Airplane has deviated from the selected altitude

REASON:

NOTES:

ALTITUDE CALLOUTS

CONDITION:

- Altitude callouts are no longer provided

REASON:

NOTES:

CONFIG: DOORS; FLAPS; GEAR STEERING; RUDDER; SPOILERS; STABILISER; PARKING BRAKE; GEAR ..... Warning Message with Siren

CONDITION:

- Either Engines thrust is on the takeoff range and:
  - A door is not closed and latched and locked
  - Flaps are not is a takeoff position
  - Main Gear steering is unlocked
  - Rudder Trim is no centred
  - Stabiliser is not within the Greenband
  - Parking Brake is set
- Gear:
  - Any Gear is not down and locked and
    - Either thrust lever is closed below 800ft
    - Flaps are in a landing position

NOTES:

□ CONFIG WARNING SYS

CONDITION:

- A fault is detected in the configuration warning system

REASON:

CHECKLIST:

- Notes: Radio Altitude voice callout and other aural alerts may not be available

NOTES:

□ GND PROX SYS

CONDITION:

- Ground Proximity alerts may not be provided

REASON:

CHECKLIST:

- Notes: Some or all GPWS alerts are not available
- GPWS alerts which occur are valid

NOTES:

OVERSPEED ..... Warning Message with Siren

CONDITION:

- Airspeed has exceeded Vmo/Mmo

REASON:

NOTES:

□ TAIL STRIKE ..... Caution Message with Beeper

CONDITION:

- A Tail Strike has been detected

REASON:

CHECKLIST:

- Both Outflow valves are put to Manual and Opened to depressurize the aircraft.
- **Plan to land at Nearest Suitable Airport**

NOTES:

- EKIB 12 773 may continue flight

TCAS

CONDITION:

- TCAS has failed

REASON:

NOTES:

TCAS OFF

CONDITION:

- TCAS is in standby mode

REASON:

NOTES

TCAS RA CAPTAIN / FO

CONDITION:

- TCAS cannot display RA guidance on the affected PFD

REASON:

NOTES:

- Make the other pilot the PF so that a control handover does not have to take place if a TCAS RA occurs

TERR OVRD

CONDITION:

- Ground Proximity terrain override switch is in OVRD

REASON:

NOTES:

□ TERR POS

CONDITION:

REASON:

CHECKLIST:

NOTES:

□ WINDSHEAR SYS

CONDITION:

REASON:

CHECKLIST:

NOTES: